MAUSAM, **71**, 2 (April 2020), 329-356

Weather in India

HOT WEATHER SEASON (March-May 2019)†

1. Chief features

The first cyclonic storm of the season, Extremely Severe Cyclonic Storm (ESCS "Fani" 26th April - 4th May, 2019) formed over the Bay of Bengal and crossed the Odisha coast close to Puri. Besides this ESCS, one short lived low pressure area formed on 30th May over southwest Arabian Sea off Somalia coast which dissipated on 31st May.

*Heat wave conditions** were observed over Peninsular India in the second week of March and over northwestern and central parts of the country during the last week of March. In the month of April, heat wave conditions persisted over parts of central India and northwest India upto 15th and again in the last week of the month. In May the heat waves were more frequent and intense over central India and adjoining Peninsular region.

There were occurrences of hailstorms or thunderstorms over the country from the second fortnight of April. They were frequent over east and north eastern regions, some parts of northern India and Peninsula. These were either absent or less frequent over central India particularly Maharashtra and Gujarat states.

Rainfall activity over the country during the season as a whole was *deficient* [78% of Long Period Average (LPA) value)]. It was deficient in March (62% of LPA) and April (80% of LPA) and normal in May (83% of LPA, respectively).

Southwest Monsoon advanced into South Andaman Sea, some parts of South Bay of Bengal and Nicobar Islands on the 18th May, 2019, two days prior of the normal date (20th May).

2. Seasonal rainfall

The sub-division wise rainfall and its departure from *normal* for each month and for the season as a whole are given in Table 1. The sub-divisionwise rainfall departures for the season March-May 2019 are also depicted in Fig. 1.

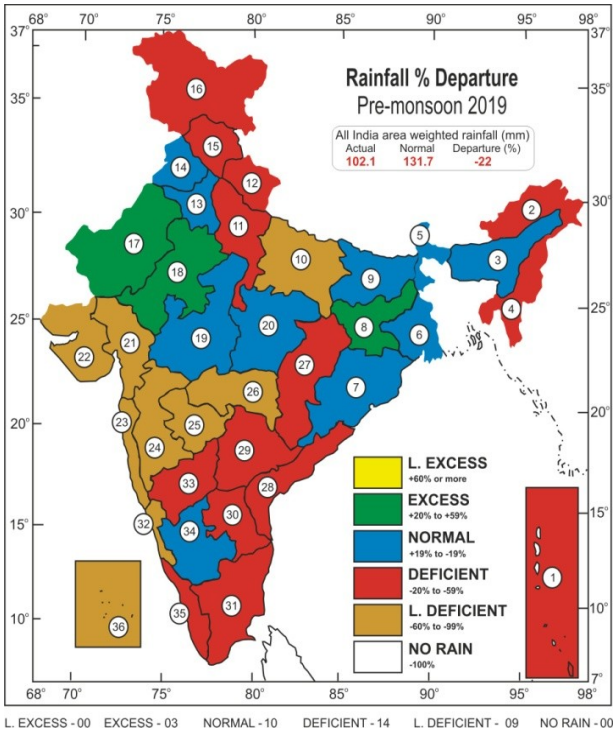

Fig. 1. Sub-divisional rainfall percentage departures (based on Operational data) for the season Mar-May, 2019. Sub-divisions are indicated by number on the map & bold letters in legend. The rainfall anomaly values for these 36 sub-divisions are indicated below :

1	-40	**7**	16	**13**	-7	**19**	3	**25**	-81	**31**	-59
2	-26	**8**	32	**14**	-2	**20**	4	**26**	-75	**32**	-71
3	12	**9**	-15	**15**	-45	**21**	-82	**27**	-20	**33**	-47
4	-36	**10**	-70	**16**	-35	**22**	-90	**28**	-42	**34**	-18
5	-3	**11**	-40	**17**	45	**23**	-98	**29**	-53	**35**	-53
6	19	**12**	-35	**18**	39	**24**	-69	**30**	-45	**36**	-81

The rainfall in the month of March was subdued over the entire country, the deficiency was highest in the month of March for all the regions and for the country as a whole, with south Peninsular region being the worst hit with only 28% of LPA rainfall. In April there was an increased rainfall activity over all the regions, as compared to March. While Northwest India and South Peninsula remained *deficient*, East & North East Region was normal. Also Central India region was *normal* due to the enhanced thunder activity especially over Gujarat and

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

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TABLE 1

Sub-division rainfall (mm) for each month and season as a whole (March–May 2019)

S. No.	Meteorological Sub-divisions	March			April			May			Season		
		Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)
1.	Andaman & Nicobar Islands	15.8	27.9	-43%	35.3	74.2	-52%	230.9	364.7	-37%	282.0	466.8	-40%
2.	Arunachal Pradesh	127.6	182.0	-30%	116.8	303.6	-62%	325.5	287.3	13%	573.4	772.9	-26%
3.	Assam & Meghalaya	45.1	77.3	-42%	207.9	193.9	7%	397.0	316.6	25%	659.6	587.8	12%
4.	Naga., Mani., Mizo. and Tri.	37.9	66.2	-43%	109.9	148.0	-26%	154.7	268.8	-42%	310.1	483.0	-36%
5.	Sub-Himalayan West Bengal & Sikkim	63.3	55.6	14%	132.0	125.2	5%	236.1	262.1	-10%	431.4	442.9	-3%
6.	Gangetic West Bengal	41.8	30.1	39%	61.5	50.1	23%	118.0	105.6	12%	221.3	185.8	19%
7.	Orissa	24.9	23.5	6%	38.9	33.9	15%	84.9	71.0	20%	148.6	128.4	16%
8.	Jharkhand	19.0	15.1	26%	43.9	19.6	124%	47.4	48.6	-2%	110.3	83.3	32%
9.	Bihar	3.1	8.1	-61%	32.4	16.7	94%	33.4	56.9	-41%	69.3	81.7	-15%
10.	East Uttar Pradesh	4.8	6.7	-29%	3.0	6.0	-49%	1.9	19.7	-91%	9.7	32.4	-70%
11.	West Uttar Pradesh	5.6	9.2	-39%	7.4	5.4	37%	5.1	15.3	-67%	18.1	29.9	-40%
12.	Uttaranchal	33.8	54.9	-38%	39.5	34.8	14%	27.8	65.6	-58%	101.1	155.3	-35%
13.	Haryana, Chandigarh & Delhi	7.7	12.1	-36%	11.4	7.9	44%	17.6	19.3	-9%	36.7	39.3	-7%
14.	Punjab	9.4	23.7	-60%	23.9	13.5	77%	20.9	17.9	17%	54.2	55.1	-2%
15.	Himachal Pradesh	60.7	110.9	-45%	32.5	65.7	-50%	41.3	66.8	-38%	134.5	243.4	-45%
16.	Jammu & Kashmir	84.6	153.2	-45%	57.4	102.8	-44%	76.4	80.1	-5%	219.3	336.1	-35%
17.	West Rajasthan	1.6	4.5	-64%	6.8	4.9	39%	24.2	13.1	84%	32.6	22.5	45%
18.	East Rajasthan	0.8	3.5	-77%	17.6	3.7	376%	8.1	11.8	-32%	26.5	19.0	39%
19.	West Madhya Pradesh	1.7	4.4	-61%	9.9	2.1	370%	1.7	6.4	-74%	13.3	12.9	3%
20.	East Madhya Pradesh	13.5	10.8	25%	8.9	4.8	86%	2.2	8.0	-73%	24.6	23.6	4%
21.	Gujarat region	0.0	1.0	-100%	1.0	0.7	37%	0.2	4.6	-96%	1.1	6.3	-82%
22.	Saurashtra & Kutch	0.0	1.0	-99%	0.3	0.3	5%	0.1	2.7	-97%	0.4	4.0	-90%
23.	Konkan & Goa	0.0	1.0	-100%	0.4	2.0	-79%	0.3	33.0	-99%	0.7	36.0	-98%
24.	Madhya Maharashtra	1.7	2.9	-41%	5.3	7.2	-27%	1.6	22.4	-93%	10.1	32.5	-69%
25.	Marathawada	0.3	6.0	-95%	4.5	5.5	-17%	0.6	15.9	-96%	5.2	27.4	-81%
26.	Vidarbha	3.8	10.4	-63%	2.6	6.5	-59%	0.4	10.5	-96%	6.9	27.4	-75%
27.	Chattisgarh	12.2	10.6	15%	8.2	12.4	-34%	12.3	18.0	-32%	32.6	41.0	-20%
28.	Coastal Andhra Pradesh	7.1	13.5	-48%	22.6	22.3	1%	27.8	62.9	-56%	57.5	98.7	-42%
29.	Telangana	2.1	11.6	-82%	13.9	17.2	-19%	11.6	30.1	-61%	27.6	58.9	-53%
30.	Rayalaseema	0.1	9.3	-99%	10.9	18.7	-42%	33.9	54.1	-37%	44.9	82.1	-45%
31.	Tamil Nadu	3.1	21.4	-86%	18.5	39.9	-54%	29.9	65.1	-54%	51.5	126.4	-59%
32.	Coastal Karnataka	3.5	7.8	-55%	22.6	26.2	-14%	18.9	121.7	-84%	45.0	155.7	-71%
33.	North interior Karnataka	4.8	7.4	-35%	19.6	23.4	-16%	18.4	49.2	-63%	42.8	80.0	-47%
34.	South interior Karnataka	2.0	11.3	-82%	33.0	42.4	-22%	79.5	86.7	-8%	114.5	140.4	-18%
35.	Kerala	13.9	32.7	-57%	93.5	105.1	-11%	62.1	223.7	-72%	169.6	361.5	-53%
36.	Lakshadweep	4.1	10.7	-62%	22.4	35.2	-36%	11.4	157.4	-93%	37.9	203.3	-81%

Note : Amounts less than 0.1 mm are rounded off to zero

TABLE 2

Details of the weather systems during March 2019

S. No.	System	Duration	Place of initial location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Western Disturbances (WDs) / Eastward moving systems*					
(*i*)	*Upper air cyclonic circulation*					
1.	Between 3.1 & 3.6 kms a.s.l.	1-4	East Afghanistan and neighbourhood	East	North Pakistan and adjoining Jammu & Kashmir	Seen with trough aloft with its axis at 4.5 km a.s.l. roughly along Long. 64° E to the north of Lat. 28° N on 1. It moved away northeastwards
2.	At 3.1 kms a.s.l.	6-9	Western parts of Afganistan & neighbourhood	East northeast	Eastern parts of Jammu & Kashmir	Initially, it lay as a trough in mid-tropospheric westerlies with its axis at 3.1 kms a.s.l. ran roughly along Long. 56° E to the north of Lat. 26° N on 5 & moved away east northeastwards on 8. However WD as a cyclonic circulation moved away east-northeastwards on 10
3.	Upto 5.8 kms a.s.l.	8-14	West Iran & neighbourhood	Do	Eastern parts of Jammu & Kashmir and neighbourhood	A trough aloft at 7.6 km a.s.l. ran roughly along Long. 66° E to the north of Lat. 24° N on 11 & became less marked on 12. Again trough aloft with its axis at 5.8 km a.s.l. ran roughly along Long. 68° E to the north of Lat. 18° N on 14. WD as a cyclonic circulation became less marked on 15. However trough moved away east northeastwards on 16
4.	At 3.1 kms a.s.l.	12-13	Iran and neighbourhood	East	Central parts of Pakistan and neighbourhood	A trough aloft with its axis at 5.8 km a.s.l. ran roughly along Long. 54° E to the north of Lat. 27° N. It moved away east northeastwards on 14
5.	Do	16-18	East Afghanistan and neighbourhood	Do	Eastern parts of Jammu & Kashmir and neighbourhood	A trough aloft with its axis at 5.8 km a.s.l. ran roughly along Long. 55° E to the north of Lat. 34° N on 16 & became less marked on 18. WD as a cyclonic circulation moved away eastwards in the evening of 18
6.	Do	19-20	Afghanistan and neighbourhood	Do	North Pakistan and adjoining Jammu & Kashmir	Initially, it lay as a trough in mid tropospheric westerlies with its axis at 5.8 km a.s.l. roughly along Long. 55° E to the north of Lat. 30° N on 18. WD as a cyclonic circulation moved away east northeastwards on 21. Trough moved away east northeastwards on 22
7.	Upto 1.5 km a.s.l.	22-25	Iran and neighbourhood	Do	Punjab and Jammu & Kashmir	A trough aloft with its axis at 5.8 km a.s.l. ran roughly along Long. 55° E to the north of Lat. 34° N on 22 & moved away east northeastwards on 24. WD as a cyclonic circulation then lay as a trough in mid tropospheric westerlies with its axis at 3.1 km a.s.l. roughly along Long. 78° E to the north of Lat. 28° N on 26 & moved away east northeastwards on 27
(*ii*)	*As a trough*					
1.	At 5.8 kms a.s.l.	5	Along Long. 72° E to the north of Lat. 32° N	-	-	It moved away east-northeastwards on 6

TABLE 2 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.	At 5.8 kms a.s.l.	28-31	Along Long. 65° E to the north of Lat. 32° N	East	Along Long. 78° E to the north of Lat. 32° N	It moved away eastwards on 1 April
(*iii*)	*As an Induced cyclonic circulation*					
1.	At 1.5 km a.s.l.	1-4	Southwest Rajasthan and neighbourhood	East	East Rajasthan and adjoining northwest Madhya Pradesh	Became less marked on 5
2.	Upto 0.9 km a.s.l.	8	Punjab and neighbourhood	Stationary	*In situ*	Became less marked on 9
3.	Upto 1.5 km a.s.l.	11	West Rajasthan and neighbourhood	Do	Do	Became less marked on 12
4.	Upto 0.9 km a.s.l.	13-14	Southwest Rajasthan and neighbourhood	East	Southeast Rajasthan & adjoining Gujarat region and west Madhya Pradesh	Became less marked on 15
5.	At 1.5 km a.s.l.	17-18	Punjab and neighbourhood	Stationary	*In situ*	Became less marked on 19
6.	Upto 1.5 km a.s.l.	20-21	Northwest Rajasthan and neighbourhood	Northeast	Punjab and neighbourhood	Became less marked on 22
7.	Do	23-24	South Pakistan and neighbourhood	West	West Rajasthan and neighbourhood	Became less marked on 25
(**B**)	*Other upper air cyclonic circulations*					
1.	At 0.9 km a.s.l.	1	South coastal Odisha & neighbourhood	Stationary	*In situ*	Became less marked on 2
2.	Upto 1.5 km a.s.l	1	North interior Karnataka and adjoining Telangana	Do	Do	Became less marked on 2
3.	At 1.5 km a.s.l.	1	Southeast Arabian Sea off south Kerala coast	Do	Do	Became less marked on 2
4.	Between 0.9 & 2.1 kms a.s.l.	2-3	Bangladesh and neighbourhood	Do	Do	Became less marked on 4
5.	Between 3.1 & 3.6 kms a.s.l.	2	Lakshadweep area and neighbourhood	Do	Do	Became less marked on 3
6.	Upto 0.9 kms a.s.l.	3	Southwest Madhya Pradesh and neighbourhood	Do	Do	Became less marked on 4
7.	Upto 1.5 kms a.s.l.	3	Comorin area and neighbourhood	Do	Do	Became less marked on 4
8.	Do	4	Central Assam and neighbourhood	Do	Do	A trough aloft at 3.1 kms a.s.l. also extended roughly along Long. 72° E to the north of Lat. 26° N and became less marked on 5
9.	At 0.9 km a.s.l.	6-8	Northeast Assam and neighbourhood	West	Central Assam & neighbourhood	Became less marked on 9
10.	At 1.5 km a.s.l.	7-9	Comorin area & adjoining Tamil Nadu	South	Comorin area & neighbourhood	Became less marked on 10
11.	At 0.9 km a.s.l.	8	Southwest Rajasthan and neighbourhood	Stationary	*In situ*	Became less marked on 9
12.	Do	8-9	North interior Karnataka and neighbourhood	Do	Do	Merged with the trough/wind discontinuity that ran from Marathwada to Comorin area on 10
13.	Do	8	Southeast Arabian Sea off Kerala coast	Do	Do	Became less marked on 9
14.	Upto 0.9 km a.s.l.	9	Northwest Madhya Pradesh and neighbourhood	Do	Do	Became less marked on 10

TABLE 2 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
15.	At 3.1 kms a.s.l.	9	Punjab and neighbourhood	Stationary	*In situ*	Became less marked on 10
16.	At 1.5 kms a.s.l.	10	South interior Karnataka and neighbourhood	Do	Do	Became less marked on 11
17.	Upto 0.9 km a.s.l.	11	Sub Himalayan West Bengal and neighbourhood	Do	Do	Became less marked on 12
18.	Between 1.5 & 2.1 km a.s.l.	11-12	Northeast Assam and neighbourhood	Do	Do	Became less marked on 13
19.	Upto 0.9 km a.s.l.	12-13	South coastal Tamil Nadu and neighbourhood	South	Comorin area & neighbourhood	It became less marked on 14
20.	At 1.5 km a.s.l.	13	North Punjab and neighbourhood	Stationary	*In situ*	Merged with the WD as a cyclonic circulation over north Pakistan & neighbourhood on 14
21.	Upto 0.9 km a.s.l.	13-15	Vidarbha & adjoining south Madhya Pradesh	Southeast	Vidarbha & adjoining Telangana	It became less marked on 16
22.	Upto 1.5 km a.s.l.	13-14	West Assam and neighbourhood	East	Assam & Meghalaya and neighbourhood	It became less marked on 15
23.	Upto 0.9 km a.s.l.	14-15	Interior Odisha and neighbourhood	South	South Odisha and neighbourhood	It became less marked on 16
24.	Do	16-21	South interior Karnataka and neighbourhood	East	North interior Karnataka and adjoining Telangana	Merged with the trough ran from west Madhya Pradesh to north interior Karnataka and adjoining Telangana on 22
25.	At 1.5 km a.s.l.	16-17	Vidarbha & adjoining areas of Chattisgarh	West	Vidarbha & neighbourhood	It became less marked on 18
26.	At 0.9 km a.s.l.	17-19	Central Assam & neighbourhood	Stationary	*In situ*	It became less marked on 20
27.	At 1.5 kms a.s.l.	18	Central parts of Madhya Pradesh and neighbourhood	Do	Do	It became less marked on 19
28.	Upto 1.5 kms a.s.l.	21-22	Northwest Madhya Pradesh & neighbourhood	South	West Madhya Pradesh and neighbourhood	It became less marked on 23
29.	Between 1.5 & 2.1 kms a.s.l.	22	Northeast Assam and neighbourhood	Stationary	*In situ*	It became less marked on 23
30.	Upto 0.9 km a.s.l.	23-25	Central Assam and neighbourhood	East	South Assam & Meghalaya and neighbourhood	It became less marked on 26
31.	Upto 1.5 kms a.s.l.	24	South Madhya Maharashtra and adjoining north interior Karnataka	Stationary	*In situ*	It became less marked on 25
32.	Upto 0.9 km a.s.l.	25	Southwest Madhya Pradesh and neighbourhood	Do	Do	It became less marked on 26
33.	Upto 1.5 km a.s.l.	26	Northern parts of West Bengal and neighbourhood	Do	Do	It became less marked on 27
34.	Between 0.9 & 1.5 km a.s.l.	27-29	South Madhya Maharashtra and neighbourhood	South	South Madhya Maharashtra & adjoining north interior Karnataka	It became less marked on 30
35.	At 0.9 km a.s.l.	27	South interior Odisha	Stationary	*In situ*	It became less marked on 28

TABLE 2 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
36.	At 0.9 km a.s.l.	27	South Assam and neighbourhood	Stationary	*In situ*	It became less marked on 28
37.	Upto 0.9 km a.s.l.	29 Mar-1 Apr	South Jharkhand and adjoining areas of Chhattisgarh and interior Odisha	East	Northern parts of West Bengal & neighbourhood	Initially it lay as a trough at 0.9 km above m.s.l. ran from Gangetic West Bengal to interior Odisha on 28. A trough aloft cyclonic circulation extending up to 3.6 km above m. s. l. lay over the same region on 30. Became less marked on 2 April
38.	At 1.5 km a.s.l.	29	Southeast Uttar Pradesh and neighbourhood	Stationary	*In situ*	It became less marked on 30
39.	Upto 0.9 km a.s.l.	30	Northwest Rajasthan and neighbourhood	Do	Do	It became less marked on 31
40.	Do	30	Central parts of Madhya Pradesh	Do	Do	It became less marked on 31
41.	At 1.5 km a.s.l.	30	Southern parts of Telangana and neighbourhood	East	Telangana & adjoining north interior Karnataka	It became less marked on 1 April
42.	Do	31	Northwest Madhya Pradesh & neighbourhood	Stationary	*In situ*	It became less marked on 1 April
43.	Upto 1.5 km a.s.l.	31 Mar - 1 Apr	South Assam & neighbourhood	East	Manipur and neighbourhood	It became less marked on 2 April
44.	At 3.1 km above m.s.l.	31 Mar - 1 Apr	Malay Peninsula and adjoining south Andaman Sea	Stationary	*In situ*	It became less marked on 2 April
(**C**)	*Trough in easterlies/Trough of Low*					
1.	At mean sea level	18-19	Maldives-Comorin area	South	Maldives area & adjoining Equatorial Indian Ocean	It moved away westwards on 20
2.	Upto 0.9 km a.s.l.	20-21	Equatorial Indian Ocean to Andaman Sea	Do	Equatorial Indian Ocean and adjoining south Andaman Sea	Became less marked on 22
3.	At mean sea level	20-21	Lakshadweep area and neighbourhood	Do	Maldives and adjoining Lakshadweep area	It moved away westwards on 22
4.	Do	24-27	Equatorial Indian Ocean and adjoining south Andaman Sea	Southeast	Equatorial Indian Ocean and adjoining southeast Bay of Bengal	Became less marked on 28
5.	At 1.5 km a.s.l.	28	Southwest Bay of Bengal to south interior Karnataka across Gulf of Mannar & interior Tamil Nadu	Stationary	*In situ*	Became less marked on 29
(**D**)	*Trough in westerlies/Trough of low*					
1.	At 0.9 km a.s.l.	1	Cyclonic circulation over north interior Karnataka & adjoining Telangana to Comorin area across Rayalaseema & interior Tamil Nadu	Stationary	*In situ*	Became less marked on 2
2.	Do	3	Cyclonic circulation over southwest Madhya Pradesh & neighbourhood to north Interior Karnataka across Madhya Maharashtra	Do	Do	Became less marked on 4

TABLE 2 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.	At 0.9 kms a.s.l.	4	From Comorin area to south interior Karnataka across interior Tamil Nadu	Stationary	*In situ*	Became less marked on 5
4.	Upto 0.9 kms a.s.l.	4	Cyclonic circulation over east Rajasthan & adjoining northwest Madhya Pradesh to Vidarbha across Madhya Pradesh	Do	Do	Became less marked on 5
5.	At 0.9 kms a.s.l.	5	West Assam to south Chattisgarh across West Bengal & interior Odisha	Do	Do	Became less marked on 6
6.	Upto 1.5 kms a.s.l.	5	From north interior Tamil Nadu to Comorin area	Do	Do	Became less marked on 6
7.	At 0.9 km a.s.l.	6-7	North coastal Andhra Pradesh to Comorin area across Rayalaseema & interior Tamil Nadu	East	Northwest Bay of Bengal to Comorin area across south coastal Odisha, coastal Andhra Pradesh, Rayalaseema & interior Tamil Nadu	Became less marked on 8
8.	Do	10-12	Marathwada to Comorin area across Interior Karnataka & Tamil Nadu	Oscillatory	Chattisgarh to north interior Karnataka across Vidarbha & Marathwada	Became less marked on 13
9.	Do	10	Northern parts of Gangetic West Bengal to south Chattisgarh	Stationary	*In situ*	Became less marked on 11
10.	Do	13-14	Vidarbha & adjoining south Madhya Pradesh to north interior Karnataka across Marathwada	Do	Do	Became less marked on 15
11.	Upto 0.9 km a.s.l.	13	West Assam & neighbourhood to northeast Jharkhand across West Bengal	Do	Do	Became less marked on 14
12.	At 1.5 km a.s.l.	15	Western parts of Vidarbha to coastal Karnataka across Marathwada & north interior Karnataka	Do	Do	Became less marked on 16
13.	At 0.9 km a.s.l.	20-22	North Bihar to Manipur across northern parts of West Bengal and Assam & Meghalaya	Do	Do	Became less marked on 23
14.	Do	21	Northwest Madhya Pradesh to western parts of Vidarbha	South	Northwest Madhya Pradesh to north interior Karnataka & adjoining Telangana across Vidarbha	Became less marked on 23
15.	Do	23	North Kerala to Telangana across interior Karnataka	Stationary	*In situ*	Became less marked on 24

TABLE 2 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
16.	At 0.9 km a.s.l.	24	Cyclonic circulation over south Madhya Maharashtra and adjoining north Interior Karnataka to south Tamil Nadu across south Interior Karnataka	Stationary	*In situ*	Became less marked on 25
17.	At 1.5 kms a.s.l.	24	Longitude 87° E to the north of Latitude 25° N	Do	Do	Became less marked on 25
18.	Upto 1.5 kms a.s.l.	25	North Bihar to south Assam	Do	Do	Became less marked on 26
19.	Upto 0.9 km a.s.l.	25-26	Lakshadweep area to south Madhya Maharashtra across north interior Karnataka	North	Lakshadweep area to east Madhya Pradesh across north interior Karnataka, Marathawada & Vidarbha	Became less marked on 27
20.	At 3.1 kms a.s.l.	26	Longitude 93° E to the north of Latitude 25° N	Stationary	*In situ*	Became less marked on 27
21.	At 0.9 km a.s.l.	27	East Bihar to eastern parts of Gangetic West Bengal	Do	Do	Became less marked on 28
22.	Upto 0.9 km a.s.l.	31 Mar - 1 Apr	East Uttar Pradesh to central parts of Chhattisgarh across east Madhya Pradesh	East	West Bihar to northeast Vidarbha across east Madhya Pradesh	Became less marked on 2 April
23.	Do	31 Mar - 1 Apr	Rayalaseema to Comorin area across interior Tamil Nadu	Stationary	*In situ*	Became less marked on 2 April

Madhya Pradesh states. The monthly May rainfall was *normal* in the east northeast region, northwest India and *deficient* in central India and south Peninsular region.

The seasonal rainfall for the country was *deficient* (78% of LPA) so was northwest India (69% of LPA) and south Peninsular region (54% of LPA), while precipitation over east northeast region and central India remained *normal*. During the season, out of 36 meteorological sub-divisions, no meteorological sub-division received *large excess* rainfall, 3 subdivisions received *excess* rainfall while 10 received *normal* rainfall, 14 sub-divisions received *deficient* rainfall and 9 *large deficient* rainfall. The peninsular region recorded *deficient* rainfall in all the months and the season and all the sub-divisions in this region were either *deficient* or *large deficient* in the season except South Interior Karnataka which was normal.

3. Significant features during various months

3.1. *March*

3.1.1. *Weather and associated synoptic features*

The rainfall for the month was *deficient* for the country (62% of LPA) as a whole as well for all the regions except Central India (89% of LPA). 3 Met sub-division (Gangetic West Bengal, Jharkhand and East Madhya Pradesh) reported excess rainfall. There are 3 sub-divisions with *normal* rainfall, 15 *deficient*, 13 *large deficient* and 2 sub-divisions did not report any rainfall during the month. Under the influence of the western disturbances and their induced systems, precipitation occurred in the first and third week of the month over parts of northwest, northeast and central India.

3.1.2. *Temperature distribution*

(a) *Minimum temperatures*

Cold wave conditions and *Cold day* conditions occurred on 1-2 days over some parts of north India in the first week of March due to the weather associated with an intense western disturbance.

The minimum temperatures were on most days *below normal* / *appreciably below normal* and on a few days *markedly below normal* in the northwest and northeast India in the first fortnight of the month. Rise in the temperatures in these areas was observed after the third week. In southern India temperatures remained *above normal or appreciably above normal* particularly

TABLE 3

Details of the weather systems during April 2019

S. No.	System	Duration	Place of initial location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Cyclonic storm*					
1.	Extremely severe cyclonic storm (FANI)	26 Apr - 4 May	Southeast Bay of Bengal and adjoining east Equatorial Indian Ocean	Northwest/ northeast	Bangladesh	It weakened into Depression and further into a well marked low pressure area on 4 May. The associated cyclonic circulation extending upto 1.5 km above m.s.l. lay over north Myanmar & neighbourhood on 4 and Became less marked on 5
(**B**)	*Western Disturbances/Eastward moving Systems*					
(*i*)	*Upper air cyclonic circulation*					
1.	At 3.1 kms a.s.l.	4-8	East Afghanistan and neighbourhood	East	Jammu & Kashmir and neighbourhood	Initially it lay as a trough in mid-tropospheric westerlies ran with its axis at 5.8 kms a.s.l. roughly along Long. 52° E to the north of Lat. 32° N on 3. WD moved away east-north-eastwards on 9
2.	Do	9-11	Northeast Afghanistan and neighbourhood	Do	Do	Initially it lay as a trough in mid-tropospheric westerlies ran with its axis at 5.8 kms a.s.l. roughly along Long. 50° E to the north of Lat. 32° N on 8. WD and trough moved away east-northeastwards on 12
3.	Do	11-14	Eastern parts of Iran & adjoining Afghanistan	Do	North Pakistan and neighbourhood	Initially it lay as a trough in mid-tropospheric westerlies ran with its axis at 5.8 kms a.s.l. roughly along Long. 54° E to the north of Lat. 30° N on 10. WD moved away eastwards on 15
4.	Do	13-18	Iran and neighbourhood	Do	North Pakistan and adjoining Jammu & Kashmir	A trough aloft lay in mid & upper tropospheric westerlies with its axis at 5.8 kms a.s.l. roughly along Long. 54° E to the north of Lat. 25° N on 14. WD as a cyclonic circulation became less marked on 19. However, WD as a trough moved away northeastwards on 21
5.	Upto 3.1 kms a.s.l.	19-23	Western parts of Iran and neighbourhood	Do	Iran and adjoining Afghanistan	It merged with the WD as a cyclonic circulation over east Iran & adjoining Afghanistan on 24
6.	At 3.1 kms a.s.l.	20-21	North Pakistan & neighbourhood	Do	Northern parts of Jammu & Kashmir and neighbourhood	It moved away east northeastwards on 22
7.	Do	24-27	East Iran & adjoining Afghanistan	Do	Jammu & Kashmir and neighbourhood	With a trough aloft in mid tropospheric westerlies with its axis at 5.8 kms a.s.l. running roughly Long. 55° E to the north of Lat. 32° N on 24. Became unimportant on 27. WD moved away east northeastwards on 28
(*ii*)	*As a trough*					
1.	At 3.1 kms a.s.l.	7	Roughly along Long. 64° E to the north of Lat. 28° N	Stationary	*In situ*	Merged with the WD as a cyclonic circulation over eastern parts of Jammu & Kashmir on 8
2.	Do	29 Apr - 6 May	Roughly along Long. 60° E to the north of Lat. 28° N	East	Roughly along Long. 86° E to the north of Lat. 34° N	The WD as a trough lay as a cyclonic circulation over North Pakistan & neighbourhood between 3.1 & 7.6 kms a.s.l. with trough aloft on 2 May and became less marked on 4 May. However, trough moved away eastwards on 7 May

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(*iii*)	*As an induced cyclonic circulation*					
1.	At 1.5 kms a.s.l.	13-14	West Rajasthan & adjoining Pakistan	East	Northwest Rajasthan & neighbourhood	Became less marked on15
2.	Upto 1.5 kms a.s.l.	15-18	Southwest Rajasthan & neighbourhood	Do	Northeast Rajasthan & neighbourhood	Became less marked on 19
3.	Do	25-26	Central Pakistan and adjoining west Rajasthan	Do	West Rajasthan and neighbourhood	Became less marked on 27
4.	Do	30	Northwest Rajasthan & neighbourhood	Stationary	*In situ*	Initially it lay as a cyclonic circulation at 0.9 km a.s.l. over west Rajasthan & neighbourhood on 29. It became less marked on 1 May
(**C**)	*Other upper air cyclonic circulations*					
1.	Upto 0.9 km a.s.l.	1-3	Southeast Rajasthan and neighbourhood	East	East Rajasthan and adjoining northwest Madhya Pradesh	Merged with NW-SE trough ran from south Haryana to central parts of Chhattisgarh
2.	Upto 1.5 kms a.s.l.	2	South Madhya Maharashtra & adjoining areas of north interior Karnataka & Marathwada	Stationary	*In situ*	Became less marked on 3
3.	Upto 0.9 km a.s.l.	2	Bihar and neighbourhood	Do	Do	A trough aloft between 1.5 & 2.1 kms a.s.l. ran roughly along Long. 88° E to the north of Lat. 22° N. Became less marked on 3
4.	Upto 1.5 kms a.s.l.	3-4	West Rajasthan & adjoining central Pakistan	Do	Do	Merged with the WD over eastern parts of Jammu & Kashmir and neighbourhood on 5
5.	Upto 0.9 km a.s.l.	4	East Bihar and neighbourhood	Do	Do	Became less marked on 5
6.	At 1.5 kms a.s.l.	4-5	Northeast Assam and neighbourhood	Do	Do	Became less marked on 6
7.	Upto 1.5 kms a.s.l.	5	Central Pakistan and adjoining west Rajasthan	Do	Do	Became less marked on 6
8.	Upto 0.9 km a.s.l.	5-11	Southeast Jharkhand & adjoining areas of Gangetic West Bengal & Odisha	East	South Assam & adjoining Meghalaya	Became less marked on 12
9.	Between 1.5 & 3.6 kms a.s.l.	6-8	Meghalaya and neighbourhood	Do	Northeast Assam and neighbourhood	Became less marked on 9
10.	Upto 0.9 km a.s.l.	7-8	Northeast Rajasthan and neighbourhood	Stationary	*In situ*	Became less marked on 9
11.	Do	9	Northeast Rajasthan and neighbourhood	Do	Do	Became less marked on 10
12.	At 3.1 kms a.s.l.	10	West Assam & adjoining Sub-Himalayan West Bengal	Do	Do	Became less marked on 11
13.	Between 1.5 & 3.6 kms a.s.l.	10-11	Malay peninsula	Do	Do	Became less marked on 12
14.	Between 1.5 & 2.1 kms a.s.l.	11-15	Sub-Himalayan West Bengal & adjoining Bihar	East	Meghalaya & neighbourhood	Became less marked on 16
15.	Upto 1.5 kms a.s.l.	12-13	Northwest Madhya Pradesh and neighbourhood	Do	Central parts of Madhya Pradesh	Became less marked on 14

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
16.	Upto 1.5 km a.s.l.	12	South Madhya Maharashtra	Stationary	*In situ*	Became less marked on 13
17.	Upto 0.9 km a.s.l.	13-15	Northern parts of east Uttar Pradesh and neighbourhood	Do	Do	Became less marked on 16
18.	At 1.5 kms a.s.l.	14- 15	Coastal Karnataka and neighbourhood	South	South interior Karnataka and neighbourhood	Became less marked on 16
19.	At 0.9 km a.s.l.	15	South Rajasthan and neighbourhood	Stationary	*In situ*	Became less marked on 16
20.	Do	15-16	Madhya Maharashtra and neighbourhood	South	South Madhya Maharashtra and neighbourhood	Became les marked on 17
21.	At 1.5 kms a.s.l.	17	North interior Karnataka and neighbourhood	Stationary	*In situ*	Became less marked on 18
22.	Upto 1.5 kms a.s.l.	17-18	East Assam and neighbourhood	Do	Do	Became less marked on 19
23.	Upto 0.9 km a.s.l.	18	Southeast Rajasthan and neighbourhood	Do	Do	Became less marked on 19
24.	Upto 1.5 kms a.s.l.	18-19	South Chattisgarh and neighbourhood	South	Chhattisgarh and adjoining areas of Vidarbha & Telangana	Became less marked on 20
25.	Between 1.5 & 2.1 kms a.s.l.	19	Gangetic West Bengal	Stationary	*In situ*	Became less marked on 20
26.	Upto 0.9 km a.s.l.	20	North interior Karnataka and neighbourhood	Do	Do	It merged with the trough ran from south Marathwada to south interior Karnataka on 21
27.	Upto 1.5 kms a.s.l.	21	Chhattisgarh and neighbourhood	Do	Do	It became less marked on 22
28.	At 1.5 kms a.s.l.	21	Comorin area and neighbourhood	Do	Do	It became less marked on 22
29.	Upto 1.5 kms a.s.l.	22	East Jharkhand and adjoining Gangetic West Bengal	Do	Do	It became less marked on 23
30.	At 0.9 km a.s.l.	22-24	Northeast Rajasthan and neighbourhood	East	Northwest Madhya Pradesh and neighbourhood	It became less marked on 25
31.	Upto 1.5 kms a.s.l.	23	South Assam and neighbourhood	Stationary	*In situ*	It became less marked on 24
32.	At 1.5 kms a.s.l.	24-25	North Chhattisgarh and neighbourhood	East	Interior Odisha and adjoining Chhattisgarh	It became less marked on 26
33.	At 0.9 km a.s.l.	25	Interior Tamil Nadu and adjoining Kerala	Stationary	*In situ*	It became less marked on 26
34.	Do	25	South Assam and adjoining Meghalaya	Do	Do	It became less marked on 26
35.	Upto 0.9 km a.s.l.	27-28	Central parts of Madhya Pradesh	South	South Chhattisgarh and adjoining Vidarbha	It became less marked on 29
36.	At 1.5 kms a.s.l.	28	North interior Karnataka and neighbourhood	Stationary	*In situ*	It became less marked on 29
37.	Do	28	Interior Odisha & neighbourhood	Do	Do	It became less marked on 29
38.	At 0.9 km a.s.l.	29	South Assam and neighbourhood	Do	Do	It became less marked on 30
39.	Do	29-30	Northwest Madhya Pradesh and neighbourhood	Do	Do	It became less marked on 1 May

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
40.	Upto 0.9 km a.s.l.	29 Apr - 1 May	Coastal Karnataka and neighbourhood	West	East central Arabian Sea and adjoining coastal Karnataka	It became less marked on 2 May
(**D**)	*North-South troughs/wind discontinuity/other troughs*					
1.	Upto 0.9 kms a.s.l.	2-4	From cyclonic circulation over south Madhya Maharashtra and adjoining north interior Karnataka to Comorin area across interior Karnataka and interior Tamil Nadu	East	West Vidarbha to coastal Karnataka across Marathwada & Madhya Maharashtra	Became less marked on 5
2.	At 1.5 kms a.s.l.	3	North Bihar to north Bay of Bengal across Gangetic West Bengal & adjoining Bangladesh	Stationary	*In situ*	Became less marked on 4
3.	At 0.9 km a.s.l.	4-5	Cyclonic circulation over west Rajasthan and adjoining central Pakistan to north Madhya pradesh across east Rajasthan	East	Cyclonic circulation over central Pakistan and adjoining west Rajasthan to north Chattisgarh across north Madhya Pradesh	It lay as a NW-SE trough from south Haryana to central parts of Chhattisgarh across south Uttar Pradesh & east Madhya Pradesh on 6th and became less marked on 7
4.	Upto 0.9 km a.s.l.	6-11	Vidarbha to south Tamil Nadu across Marathwada and north interior Karnataka	South	South interior Karnataka to Comorin area	Merged with the trough ran from south Madhya Maharashtra to Comorin area on 12
5.	At 0.9 km a.s.l.	7-8	From cyclonic circulation over northeast Rajasthan and neighbourhood to north Chattisgarh	Do	From cyclonic circulation over northeast Rajasthan and neighbourhood to coastal Karnataka across west Madhya Pradesh & Madhya Maharashtra	Became less marked on 9
6.	At 5.8 kms a.s.l.	7	West Assam to south Bangladesh	East	Along Long. 93° E to the north of Lat. 22° N	It moved away eastwards on 9
7.	Upto 0.9 km a.s.l.	9	Cyclonic circulation over Northeast Rajasthan & neighbourhood to central Madhya Pradesh	Stationary	*In situ*	Merged with the cyclonic circulation over northeast Rajasthan & neighbourhood on 10
8.	Do	12-18	Cyclonic circulation over south Madhya Maharashtra to Comorin area across interior Karnataka & interior Tamil Nadu	East	Marathwada to Comorin area across interior Karnataka & interior Tamil Nadu	Became less marked on 19
9.	Do	13	Cyclonic circulation over northwest Madhya Pradesh & neighbourhood to south Madhya Maharashtra across Vidarbha	Stationary	*In situ*	Merged with the trough ran from northern parts of east Uttar pradesh to Madhya Maharashtra on 14
10.	At 0.9 km a.s.l.	14-15	From the cyclonic circulation over northern parts of east Uttar Pradesh and neighbourhood to Madhya Maharashtra across east Madhya Pradesh & west Vidarbha	Oscillatory	From Cyclonic circulation over northern parts of east Uttar Pradesh and neighbourhood to southwest Madhya Pradesh	Became less marked on 16

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
11.	Between 1.5 & 2.1 kms a.s.l.	15-17	Along Long. 87° E to the north of Lat. 24° N	East	Along Long. 93° E to the north of Lat. 24° N	Became less marked on 18
12.	At 0.9 km a.s.l.	16	North Bihar to Mizoram across north West Bengal & Bangladesh	Stationary	*In situ*	Became less marked on 17
13.	Do	17	East Jharkhand to south Chhattisgarh across Odisha	Do	Do	Became less marked on 18
14.	At 1.5 km a.s.l.	19-21	Chattisgarh to coastal Karnataka across east Vidarbha, Telangana & interior Karnataka	Oscillatory	South Marathwada to south interior Karnataka across north interior Karnataka	It merged with the trough ran from northeast Rajasthan to north interior Karnataka on 22
15.	At 0.9 km a.s.l.	21 -22	From the cyclonic circulation over Chhattisgarh and neighbourhood to north interior Karnataka across Vidarbha & Marathwada	Do	South Chhattisgarh to south interior Karnataka across Telangana & north interior Karnataka	Became less marked on 23
16.	Do	22	From the cyclonic circulation over northeast Rajasthan & neighbourhood to north interior Karnataka across southwest Madhya Pradesh & Maharashtra	Stationary	*In situ*	Became less marked on 23
17.	Do	24-26	Marathwada to north interior Tamil Nadu across interior Karnataka	South east	Telangana to south Tamil Nadu across Rayalaseema	Became less marked on 27
18.	At 1.5 kms a.s.l.	28	From the cyclonic storm over southeast Bay of Bengal and neighbourhood to Gulf of Mannar	Stationary	*In situ*	Became less marked on 29
19.	Do	26	East Madhya Pradesh to coastal Karnataka across Vidarbha & Marathwada	Do	Do	Became less marked on 27
20.	Do	26-27	East Bihar to north coastal Odisha across Gangetic West Bengal	East	Lay as a cyclonic circulation over northern parts of West Bengal and neighbourhood	It merged with the trough in westerlies along Long. 88° E to the north of Lat. 22° N on 28
21.	At 0.9 km a.s.l.	27-28	From the cyclonic circulation over central parts of Madhya Pradesh to south Konkan across Vidarbha & Madhya Maharashtra	Oscillatory	From the cyclonic circulation over central parts of Madhya Pradesh to south Konkan across Marathwada & Madhya Maharashtra	Became less marked on 29
22.	Do	30 Apr - 1 May	From the cyclonic circulation over northwest Madhya Pradesh to south Madhya Maharashtra	East	West Uttar Pradesh to east Vidarbha across east Madhya Pradesh	Became less marked on 2 May
(**E**)	*Trough in easterlies*					
1.	Between 1.5 & 2.1 kms a.s.l.	17-20	Equatorial Indian Ocean & adjoining Comorin-Maldives area	West	Equatorial Indian Ocean to Lakshadweep area	Became less marked on 21

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.	At 1.5 kms a.s.l.	23-25	Maldives-Comorin area to North interior Karnataka across Kerala & south interior Karnataka	Oscillatory	Maldives area to south Madhya Maharashtra across north Kerala and interior Karnataka	Became less marked on 26
(F)	*East-West trough*					
1.	Upto 1.5 kms a.s.l.	10-12	West Rajasthan to east Madhya Pradesh across the cyclonic circulation over northeast Rajasthan & neighbourhood	East	Southwest Rajasthan to south Assam across cyclonic circulation over northwest Madhya Pradesh, south Bihar, West Bengal and cyclonic circulation over Bangladesh & neighbourhood	It became less marked on 13
2.	At 3.1 kms a.s.l.	14	Sub-Himalayan West Bengal to Nagaland	Stationary	*In situ*	It became less marked on 15
3.	At 0.9 km a.s.l.	23	Cyclonic circulation over northeast Rajasthan and neighbourhood to Bangladesh across south Uttar Pradesh, Jharkhand & Gangetic West Bengal	Do	Do	Became less marked on 24
4.	At 1.5 km a.s.l.	23	East Uttar Pradesh to Vidarbha across east Madhya Pradesh	Do	Do	Became less marked on 24
5.	At 0.9 km a.s.l.	27-28	Northeast Uttar Pradesh to Manipur across Bihar, Sub-Himalayan West Bengal and Assam & Meghalaya	Oscillatory	East Bihar to Manipur across Sub-Himalayan West Bengal and Assam & Meghalaya	Became less marked on 29
(G)	*Trough in westerlys/Trough of Low*					
1.	At mean sea level	14-20	Equatorial Indian Ocean and adjoining southeast Bay of Bengal	East	Equatorial Indian Ocean and adjoining central parts of south Bay of Bengal	It became less marked on 21
2.	At 1.5 kms a.s.l.	21	Roughly along Long. 90° E and north of Lat. 25° N	Stationary	*In situ*	It became less marked on 22
3.	Do	28-30	Roughly along Long. 88° E and north of Lat. 22° N	East	Roughly along Long. 90° E and north of Lat. 22° N	It became less marked on 1 May

on most days over Rayalaseema, Tamil Nadu and some days over Kerala.

The months and the season's lowest minimum temperature over the plains was 6.5 °C at Bhatinda (Punjab) on 9th March, 2019.

(b) Maximum temperatures:

Heat wave conditions occurred on 1 or 2 days over some parts of Tamil Nadu and Rayalaseema in the beginning of the month. They started manifesting in the last week over Central and Northwest Indian subdivisions *viz.*, Vidarbha, Marathwada, Gujarat state, Rajasthan and Madhya Pradesh.

Maximum temperatures remained above normal/ appreciably above normal in the peninsular region while they generally were below normal over other parts of the country.

Low level wind confluence and moisture incursion caused fairly widespread rain or thundershowers over central and east India on a few days during the first and third week of the month bringing down the temperatures.

TABLE 4

Details of the weather systems during May 2019

S. No.	System	Duration	Place of initial location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Low Pressure Area*					
1.	At m.s.l.	30	Southwest Arabian Sea off Somalia coast	Stationary	*In situ*	Associated cyclonic circulation extended upto 5.8 km a.s.l. Became unimportant on 31
(**B**)	*Western Disturbances / Eastward moving Systems*					
(*i*)	*Upper air cyclonic circulation*					
1.	At 3.1 kms a.s.l.	7-12	Western parts of Afghanistan and neighbourhood	East	Jammu & Kashmir and neighbourhood	Initially it lay as a trough in mid & upper tropospheric levels with its axis at 5.8 kms a.s.l. along Long. 61° E and Lat. 32° N on 6. Associated trough aloft in mid tropospheric westerlies with its axis at 5.8 kms a.s.l. ran roughly along Long. 70° E and Lat. 20° N on 10. On 13, the WD lay as a trough in mid tropospheric westerlies with its axis at 5.8 kms a.s.l. ran roughly along Long. 82° E and Lat. 26° N & it moved away northeastwards on 14
2.	Do	11-15	West Iran	Do	East Iran and neighbourhood	With trough aloft in mid tropospheric westerlies with its axis at 5.8 kms a.s.l. ran roughly along Long. 53° E and Lat. 18° N on 15. WD as a cyclonic circulation merged with the WD over north Pakistan & adjoining Jammu & Kashmir & trough became less marked on 16
3.	Upto 5.8 kms a.s.l.	16-19	North Pakistan and adjoining Jammu & Kashmir	Do	Jammu & Kashmir and neighbourhood	Initially it lay as a trough with axis at 5.8 kms a.s.l. roughly along Long. 62° E and Lat. 28° N on 15 and moved away eastwards on 20
4.	At 3.1 kms a.s.l.	21-25	Iran and neighbourhood	Do	Do	With trough aloft with its axis at 5.8 km a.s.l. ran roughly along Long. 58° E and Lat. 30° N on 23. WD as a cyclonic circulation moved away northeastwards on 25 evening. The trough which lay as a remnant WD also moved away east northeastwards on 26
5.	Do	31 May - 1 Jun	Do	Do	Do	Initially it lay as a trough with axis at 3.1 kms a.s.l. roughly along Long. 55° E and Lat. 32° N on 30. WD as a cyclonic circulation moved away east northeastwards on 2 June
(*ii*)	*As a trough*					
1.	Mid & upper tropospheric levels	4-5	Along Long. 65° E to the north of Lat. 28° N (axis at 3.1 kms a.s.l.)	Stationary	*In situ*	Then it lay as a cyclonic circulation at 3.1 kms a.s.l. over west Afghanistan and neighbourhood on 5 & moved away northeastwards on 6
2.	Do	8-9	Along Long. 58° E to the north of Lat. 25° N (axis at 5.8 kms a.s.l.)	East	Along Long. 64° E to the north of Lat. 25° N (axis at 5.8 kms a.s.l.)	It merged with the trough aloft the WD over north Pakistan & neighbourhood on 10
3.	Do	17	Along Long. 64° E to the north of Lat. 22° N (axis at 5.8 kms a.s.l.)	Stationary	*In situ*	It merged with the WD as a cyclonic circulation over north Pakistan & adjoining J&K on 18

TABLE 4 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
4.	Mid & upper tropospheric levels	19-20	Along Long. 65° E to the north of Lat. 28° N (axis at 5.8 kms a.s.l.)	Stationary	*In situ*	It lay as a cyclonic circulation at 3.1 kms a.s.l. over north Pakistan and adjoining J&K with trough aloft at 5.8 kms a.s.l. along Long. 72° E to the north of Lat. 32° N on 20 & moved away eastwards on 21
5.	At 3.1 kms a.s.l.	25-28	Along Long. 64° E to the north of Lat. 28° N	East	Along Long. 79° E to the north of Lat. 32° N	It moved away northeastwards on 29 evening
(*iii*)	*An induced cyclonic circulation*					
1.	Upto 1.5 kms a.s.l.	6-9	Central Pakistan and neighbourhood	East	Central Pakistan and adjoining west Rajasthan	It became less marked on 10
2.	At 0.9 km a.s.l.	11	Punjab and neighbourhood	Stationary	*In situ*	It became less marked on 12
3.	Upto 1.5 kms a.s.l.	23-24	West Rajasthan and neighbourhood	East	East Rajasthan and neighbourhood	It became less marked on 25
(**C**)	*Other upper air cyclonic circulations*					
1.	Upto 1.5 kms a.s.l.	2	Northwest Madhya Pradesh and adjoining southwest Uttar Pradesh	Stationary	*In situ*	It merged with the trough ran from the WD as a cyclonic circulation over North Pakistan and J&K to north Rajasthan on 3
2.	Upto 0.9 km a.s.l.	2-3	Central Assam and neighbourhood	Do	Do	It became less marked on 4
3.	Upto 1.5 kms a.s.l.	4-5	South Rajasthan and adjoining Gujarat	Do	Do	It became less marked on 6
4.	At 0.9 km a.s.l.	4	Central parts of north Uttar Pradesh	Do	Do	It became less marked on 5
5.	At 1.5 kms a.s.l.	5-7	Interior Tamil Nadu	West	Southeast Arabian Sea and adjoining Lakshadweep area	It became less marked on 8
6.	Upto 1.5 km a.s.l	7-9	Sub-Himalayan West Bengal and neighbourhood	Do	North Bangladesh and neighbourhood	It became less marked on 10
7.	Between 2.1 & 3.1 kms a.s.l.	9-12	South Rajasthan and adjoining Gujarat region	Stationary	East Rajasthan and neighbourhood	It became less marked on 13
8.	At 1.5 kms a.s.l.	10-14	East Assam and adjoining Nagaland	-	East Assam and neighbourhood	Became less marked on 15
9.	Do	10	South coastal Andhra Pradesh and neighbourhood	Stationary	*In situ*	It became less marked on 11
10.	Upto 0.9 kms a.s.l.	11-13	Bihar and neighbourhood	East	East Bihar adjoining Jharkhand	It became less marked on 14
11.	Do	11	Telangana and neighbourhood	Stationary	*In situ*	It became less marked on 12
12.	Between 1.5 & 2.1 kms a.s.l.	12	South interior Karnataka and neighbourhood	Do	Do	Became less marked on 13
13.	At 0.9 km a.s.l.	13	Northeast Rajasthan and neighbourhood	Do	Do	Became less marked on 14
14.	At 1.5 kms a.s.l.	13	Off Tamil Nadu coast	Do	Do	Became less marked on 14
15.	Do	14	Punjab and neighbourhood	Do	Do	Became less marked on 15

TABLE 4 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
16.	Upto 1.5 kms a.s.l.	14	Southwest Rajasthan neighbourhood	Stationary	*In situ*	It became less marked on 15
17.	At 1.5 kms a.s.l.	14	Southern parts of Jharkhand and neighbourhood	Do	Do	It became less marked on 15
18.	At 0.9 kms a.s.l.	14	Marathwada and neighbourhood	Do	Do	It became less marked on 15
19.	At 3.1 kms a.s.l.	14	Comorin area and neighbourhood	Do	Do	It became less marked on 15
20.	Upto 0.9 km a.s.l.	15	North Rajasthan and neighbourhood	Do	Do	It became less marked on 16
21.	At 0.9 km a.s.l.	16-17	Southwest Rajasthan and neighbourhood	East	Central parts of west Rajasthan & adjoining Pakistan	Became less marked on 18
22.	At 1.5 kms a.s.l.	17	South Himachal Pradesh and neighbourhood	Stationary	*In situ*	It became less marked on 18
23.	Do	17	Northeast Rajasthan and neighbourhood	Do	Do	It became less marked on 18
24.	At 0.9 km a.s.l.	17-18	Central Assam and neighbourhood	East	East Assam and neighbourhood	It became less marked on 19
25.	At 1.5 kms a.s.l.	16-19	South interior Karnataka and neighbourhood	Stationary	*In situ*	It lay embedded in the trough from Sub-Himalayan West Bengal to south interior Karnataka on 20
26.	At 5.8 kms a.s.l.	17-23	South Andaman Sea & neighbourhood	North	North Andaman Sea & neighbourhood	It became less marked on 24
27.	At 1.5 kms a.s.l.	16	South Tamil Nadu and neighbourhood	Stationary	*In situ*	It became less marked on17
28.	At 3.1 kms a.s.l.	16	North Andaman Sea and adjoining Malay peninsula	Do	Do	It became less marked on 17
29.	Upto 1.5 kms a.s.l.	16	East Bihar and neighbourhood	Do	Do	It became less marked on 17
30.	At 0.9 km a.s.l.	18-22	Southwest Rajasthan and adjoining Pakistan	East	Southwest Rajasthan and neighbourhood	It became less marked on 23
31.	Upto 0.9 km a.s.l.	18	East Bihar and neighbourhood	Stationary	*In situ*	It became less marked on 19
32.	Between 2.1 & 3.1 kms a.s.l.	19-20	Comorin area and neighbourhood	Do	Do	It became less marked on 21
33.	At 1.5 kms a.s.l.	19-20	Coastal Tamil Nadu & neighbourhood	South	South Tamil Nadu and adjoining Gulf of Mannar & Comorin area	It became less marked on 21
34.	At 0.9 km a.s.l.	20-21	North interior Karnataka and neighbourhood	Stationary	*In situ*	It became less marked on 22
35.	Upto 1.5 kms a.s.l.	20-21	Central Assam and neighbourhood	Do	Do	It became less marked on 22
36.	At 0.9 km a.s.l.	22-24	Southeast Uttar Pradesh and neighbourhood	Do	Do	It became less marked on 25
37.	Upto 0.9 km a.s.l.	22	Bangladesh and adjoining Assam	Do	Do	Became less marked on 23
38.	At 1.5 kms a.s.l.	23	Southeast Arabian Sea and adjoining Lakshadweep area	Do	Do	Became less marked on 24

TABLE 4 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
39.	Upto 0.9 km a.s.l.	24	South interior Karnataka and neighbourhood	Stationary	*In situ*	Became less marked on 25
40.	Do	25	Northern parts of Gangetic West Bengal and neighbourhood	Do	Do	Became less marked on 26
41.	Do	25	South Assam and neighbourhood	Do	Do	Became less marked on 26
42.	Upto 1.5 kms a.s.l.	26	Southwest Rajasthan	Do	Do	Became less marked on 27
43.	Do	26-27	South Chhattisgarh and neighbourhood	East	Chhattisgarh and adjoining south Odisha	Became less marked on 28
44.	At 1.5 kms a.s.l	26-27	Kerala and neighbourhood	South	Lakshadweep area and neighbourhood	Became less marked on 28
45.	Do	27	West Assam and neighbourhood	Stationary	*In situ*	Became less marked on 28
46.	Upto 1.5 kms a.s.l.	28	East Bihar and adjoining Sub-Himalayan West Bengal & Sikkim	Do	Do	A trough aloft ran roughly along Long. 87° E to the north of Lat. 23° N at 2.1 kms a.s.l. on 28. Cyclonic circulation became less marked on 29. However, trough aloft became less marked only on 30
47.	Between 3.6 & 4.5 kms a.s.l.	28-29	Andaman Sea and adjoining Malay Peninsula	Do	Do	Merged with the NE-SW shear zone from Gulf of Martaban to southern parts of Comorin-Maldives area on 30
48.	Upto 2.1 kms a.s.l.	28-29	East Madhya Pradesh and neighbourhood	East	East Uttar Pradesh and neighbourhood	Merged with the E-W trough from Southwest Uttar Pradesh to Manipur on 30
49.	Between 3.1 & 3.6 kms a.s.l.	28-29	Southwest Rajasthan & adjoining Gujarat	South	South Gujarat & neighbourhood	Became less marked on 30
50.	At 3.1 kms a.s.l.	29	West central and adjoining northwest Bay of Bengal off north Andhra Pradesh-south Odisha coasts	Stationary	*In situ*	Became less marked on 30
51.	Upto 0.9 km a.s.l.	29-30	West Rajasthan and adjoining Pakistan	Oscillatory	Northwest Rajasthan and neighbourhood	Became less marked on 31
52.	Between 1.5 & 2.1 kms a.s.l.	30	South Chhattisgarh and adjoining Odisha	Stationary	*In situ*	Became less marked on 31
53.	Upto 0.9 km a.s.l.	30 May-1 Jun	Southwest Uttar Pradesh and neighbourhood	Oscillatory	Northeast Uttar Pradesh and neighbourhood	Became less marked on 2 June
54.	Between 3.1 & 3.6 kms a.s.l.	30 May - 1 Jun	South Pakistan and adjoining areas of Kutch & west Rajasthan	East	Southeast Rajasthan and adjoining Gujarat region	Became less marked on 2 June
55.	Between 1.5 & 2.1 kms a.s.l.	31 May - 1 Jun	Southeast Arabian Sea off Kerala coast	West	Lakshadweep area	Became less marked on 2 June
(**D**)	*East-West trough / shear zone*					
1.	Between 2.1 & 3.1 kms a.s.l.	19-22	Along Lat. 7° N	North	Along Lat. 8° N	It became less marked on 23
2.	At 0.9 kms a.s.l.	24	Eastern parts of Bihar to Mizoram across SHWB and Assam & Meghalaya	Stationary	*In situ*	It became less marked on 25

TABLE 4 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.	Between 3.1 & 4.5 kms a.s.l.	25-26	Along Lat. 7° N	Stationary	*In situ*	It became less marked on 27
4.	Upto 0.9 kms a.s.l.	29-30	From the cyclonic circulation over east Uttar Pradesh and neighbourhood to Manipur across south Bihar, Sub-Himalayan West Bengal & Assam	Oscillatory	From the cyclonic circulation over southwest Uttar Pradesh to Manipur across east Uttar Pradesh, Jharkhand, Gangetic West Bengal & Bangladesh	It became less marked on 31
5.	At 0.9 kms a.s.l.	31 May	Jharkhand to Manipur across and Gangetic West Bengal & south Assam	Stationary	*In situ*	It merged with the E-W trough from south Punjab to Manipur on 1 June
6.	Between 3.1 & 4.5 kms a.s.l.	30 May - 1 Jun	Gulf of Martaban to southern parts of Comorin-Maldives area	Do	Do	Became less marked on 2 June
(E)	*Troughs / Wind Discontinuity*					
1.	At mean sea level	1	East Uttar Pradesh to Nagaland across Bihar & Sub-Himalayan West Bengal	Stationary	*In situ*	Became less marked on 2
2.	Upto 1.5 kms a.s.l.	3	From the WD over north Pakistan & neighbourhood to north Rajasthan across Odisha & north Madhya Pradesh	Do	Do	It became less marked on 4
3.	At 0.9 kms a.s.l.	5-10	Northeast Chhattisgarh to Comorin area across Telangana, Rayalaseema & interior Tamil Nadu	East	North interior Odisha to Comorin area across south Chhattisgarh, Telangana, Rayalaseema & interior Tamil Nadu	It became less marked on 11
4.	Do	11-12	Bihar to south Chhattisgarh	Oscillatory	From the cyclonic circulation over east Bihar & neighbourhood to east Vidarbha	It became less marked on 13
5.	Do	11	From the cyclonic circulation over Telangana & neighbourhood to Comorin area	Stationary	*In situ*	It became less marked on 12
6.	Do	12-13	Rayalaseema to Comorin area	Oscillatory	Telangana to Comorin area across Rayalaseema & interior Tamil Nadu	It became less marked on 14
7.	At 1.5 kms a.s.l.	14	East Uttar Pradesh to southwest Madhya Pradesh	Stationary	*In situ*	It became less marked on 15
8.	At 0.9 kms a.s.l.	14-16	From the cyclonic circulation over Marathwada & neighbourhood to north Tamil Nadu across interior Karnataka	Oscillatory	South Madhya Maharashtra to Comorin area across interior Karnataka & interior Tamil Nadu	It became less marked on 17
9.	Do	16	From the cyclonic circulation over east Bihar & neighbourhood to Vidarbha	Stationary	*In situ*	Became less marked on 17

TABLE 4 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
10.	Upto 0.9 kms a.s.l.	17-18	South interior Karnataka to Comorin area across Tamil Nadu	Stationary	*In situ*	It became less marked on 19
11.	At 0.9 kms a.s.l.	18-20	From cyclonic circulation over east Bihar & neighbourhood to south Odisha across Jharkhand	North south	Sub-Himalayan west Bengal to south interior Karnataka across south Chhattisgarh & Telangana	It became less marked on 21
12.	Do	21-23	North interior Karnataka to Comorin area across south interior Karnataka & Tamil Nadu	Oscillatory	North interior Karnataka to Comorin area across south interior Karnataka & Tamil Nadu	Became less marked on 24
13.	Do	23	East Madhya Pradesh to north coastal Karnataka across Vidarbha, Marathwada & south Madhya Maharashtra	Stationary	*In situ*	It became less marked on 24
14.	Do	24-28	From the cyclonic circulation over south interior Karnataka & neighbourhood to south Tamil Nadu across interior Tamil Nadu	Oscillatory	Madhya Maharashtra to Comorin area across interior Karnataka & interior Tamil Nadu	It became less marked on 29
15.	Up to 0.9 kms a.s.l.	26	East Bihar to the Gangetic West Bengal	Stationary	*In situ*	It became less marked on 27
16.	At 0.9 kms a.s.l.	27	From the cyclonic circulation over Chhattisgarh & adjoining south Odisha to south Madhya Maharashtra across Vidarbha & Marathwada	Do	Do	It became less marked on 28
17.	Upto 1.5 kms a.s.l.	29-30	East Madhya Pradesh to north interior Karnataka across Vidarbha, Marathwada & Madhya Maharashtra	Oscillatory	Central parts of south Madhya Pradesh to north interior Karnataka across west Vidarbha, Marathwada & Madhya Maharashtra	It became less marked on 31
18.	At 1.5 kms a.s.l.	31 May - 1 June	From Cyclonic circulation over northeast Uttar Pradesh to north interior Karnataka across east Madhya Pradesh, Vidarbha and Marathwada	Stationary	*In situ*	It became less marked on 2 June
(**F**)	*Trough in westerlies / Trough of Low*					
1.	At mean sea level	1	East Uttar Pradesh to Nagaland across Bihar & Sub-Himalayan West Bengal	Stationary	*In situ*	Became less marked on 1
2.	At 2.1 kms a.s.l.	6-7	Along Long. 91° E to the north of Lat. 25ºN	East	Along Long. 93° E to the north of Lat. 25° N	It moved away eastwards on 8
3.	Between 3.6 & 4.5 kms a.s.l.	27	Along Long. 93° E to the north of Lat. 24° N	Stationary	*In situ*	Became less marked on 28
4.	Mid tropospheric level	31 May - 1 Jun	Along Long. 91° E to the north of Lat. 21° N	Do	Do	Became less marked on 2 June

TABLE 4 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(G)	*North-South trough*					
1.	At 1.5 kms a.s.l	9-11	Along Long. 88° E to the north of Lat. 24° N	East	Along Long. 89° E to the north of Lat. 22° N	Became less marked on 12
2.	Do	13	Along Long. 86° E to the north of Lat. 24° N	Stationary	*In situ*	Became less marked on 14
3.	Do	15	Along Long. 85° E to the north of Lat. 23° N	Do	Do	Became less marked on 16
4.	Do	19	Along Long. 88° E to the north of Lat. 21° N	Do	Do	Became less marked on 20
5.	Between 1.5 & 2.1 kms a.s.l	22-23	Along Long. 86° E to the north of Lat. 24° N	East	Along Long. 87° E to the north of Lat. 23° N	Initially it lay as a trough at 1.5 km a.s.l. extended from Bihar to interior Odisha on 21. It became less marked on 24
6.	At 0.9 kms a.s.l	30	Rayalaseema to south Tamil Nadu	Stationary	*In situ*	Became less marked on 31

The month's highest maximum temperature over the plains was 44.7 °C, recorded at Khargaon (West Madhya Pradesh) on 31st March, 2019.

3.1.3. *Disastrous weather events and damage*

According to media and other disaster reports, over thousand birds were killed in a hailstorm near Pench Tiger Reserve in Madhya Pradesh in the first week of March. Three people lost their lives by cold in a blizzard in Jammu and Kashmir's Kupwara district. Lightning claimed three lives in East Burdwan district of West Bengal as rain and thunderstorms hit Kolkata and other districts, disrupting normal life including train services. Three sun stroke deaths were reported in Kerala in the last week of the month.

3.2. *April*

3.2.1. *Weather and associated synoptic features*

The details of the weather systems during the month are given in Table 3 and the principal amounts of rainfall are given in Table 5.

Extremely Severe Cyclonic Storm (ESCS) "Fani" formed over the Bay of Bengal during 26 April - 4 May, 2019 and crossed Odisha coast close to Puri between 0230 & 0430 UTC of 3rd May, 2019. After crossing the coast, the system weakened gradually into a Cyclonic Storm over Gangetic West Bengal in the early morning of 4th May and further into a deep depression over Bangladesh and adjoining Gangetic West Bengal in the morning of 4th. In association with ESCS 'Fani', extremely heavy rainfall reported at isolated places over Odisha on 3rd and over Assam & Meghalaya on 5th May. Heavy to very heavy rainfall reported at isolated places over Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Bihar, Coastal Andhra Pradesh, Gangetic West Bengal and Tamilnadu and heavy rains at isolated places over Arunachal Pradesh, Sub-Himalayan West Bengal & Sikkim, Jharkhand, south Interior Karnataka and Tamil Nadu on one or two days.

Apart from the above, Thunderstorm activity was reported over northeast India, east India, western Himalayan region, adjoining plains of northwest India and parts of peninsular India.

A strong western disturbance adversely affected weather over northwest and adjoining central India during 15-17 April with peak activity on 16th April. The confluence of easterlies and westerlies over central India and neighbourhood further provided fresh moisture aiding the development of instability in the atmosphere & occurrence of widespread thunderstorm activity over the region.

3.2.2. *Temperature distribution*

(a) *Minimum temperatures*

The minimum temperatures over most parts of India were *normal* to *above normal* throughout the month except over north and northwestern regions where they were *above normal* to *appreciably above normal* for most days, except the third week when widespread convective activity brought a significant drop in night temperatures.

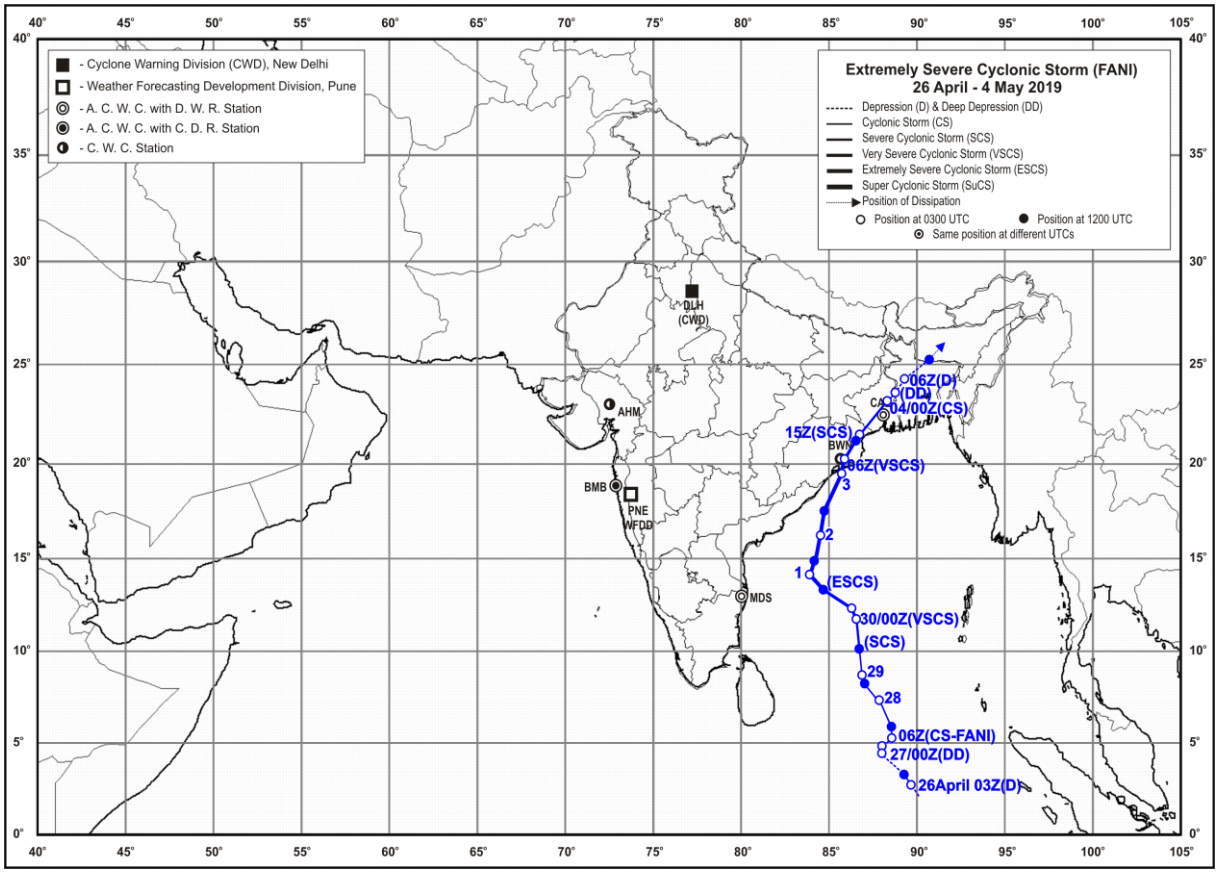

Fig. 2. Track of cyclonic storm during pre-monsoon season 2019

West Rajasthan experienced *markedly above normal* temperatures in the beginning few days of the month.

(b) *Maximum temperatures*

Severe Heat wave conditions prevailed for 1 or 2 days over East Uttar Pradesh, Rajasthan, Madhya Pradesh, Gujarat and Chhattisgarh.

Heat wave conditions prevailed for 8 days over some parts of Madhya Pradesh, seven days over Rajasthan, six days over Vidarbha, 2-4 days over Chhattisgarh, Gujarat state, Marathwada and Madhya Maharashtra and isolated pockets for one day over Haryana, Chandigarh and Delhi.

The maximum temperatures remained *normal or above normal* over the peninsular region on most days while they were *appreciably* to *markedly above normal* in the first fortnight of April over north and northwest sub-divisions on most days. In the third week, the temperatures reduced sharply over this region because of fairly widespread to widespread precipitation including thunderstorms and hailstorms. Over the north eastern region, the maximum temperatures remained *below normal / appreciably below normal* on most days because of the ongoing thundershowers.

The month's highest maximum temperature recorded over the plains was 47.5 °C at Khargaon (west Madhya Pradesh) on 28th April, 2019.

3.2.3. *Disastrous weather events*

According to media and other disaster reports : (*i*) cases of heat stroke were reported from Nagpur, Aurangabad and Latur districts in Maharashtra. (*ii*) 89 people died; many injured in northwest and western states in thunder storms mainly due to lightning strikes, (*iii*) Rain coupled with thunderstorm and lightning, hit several parts of Rajasthan, Madhya Pradesh, Gujarat and Maharashtra on 16th April, claiming over 50 lives in a single day. Extensive damage to property and crops in Punjab, Madhya Pradesh, Gujarat and Rajasthan had also been reported. The rain damaged not just the standing crop but also harvested wheat grains at various grain markets as it was lying in the open, (*iv*) Two persons lost their lives and three others injured as gusty winds and rains wreaked havoc in Hyderabad on the night of 22nd.

TABLE 5

Some representative amounts of rainfall in cm for the months March, April and May 2019 (5 cm and above)

Date	Some representative amounts of rainfall in cm for March, April and May 2019 (5 cm and above)
1 Mar	Tuting and Purushottampur 6 each, Pipili, Sankarankoil and Vizianagaram 5 each
2 Mar	Kothagiri 15, Coonoor 11, Bodinaickanur 5
3 Mar	Srungavarapukota 6, Pachmarhi 5
4 Mar	Nil
5 Mar	Midnapore and Midnapore CWC 7 each, Mohanpur 6
6 Mar	Nil
7 Mar	Nil
8 Mar	Nil
9 Mar	Nil
10 Mar	Punalur 6
11 Mar	Nil
12 Mar	Nil
13 Mar	Nil
14 Mar	Nil
15 Mar	D. P. Ghat and Kotma 5 each
16 Mar	Tuting 15, Gurundia ARG 6
17 Mar	Nil
18 Mar	Deogarh and Batli ARG 6 each, Harabhanga, Barpalli ARG and Khowai 5 each
19 Mar	Pongkhuri Nsdma AWS 6
20 Mar	Nil
21 Mar	Kotagarh 7, Kollam Rly 6, Gangtok 5
22 Mar	Nil
23 Mar	Nil
24 Mar	Nil
25 Mar	Nil
26 Mar	Sankeshwar 7, Pooh 6
27 Mar	Nil
28 Mar	Port Blair 6
29 Mar	Nil
30 Mar	Nil
31 Mar	Mohol 6, Nancowry 5
1 Apr	Kailashahar 16, Kamalpur 14, Dharmanagar / Panisagar 12, Agartala AP and Arundhutinagar 7 each, Khowai, Gharmura, Alipurduar CWC, Drf and Williamnagar 6 each; Nalbari / Pagladia, Manash Nh Xing, Barpeta, Hazuah, Kampur, Puthimari, Barapani, Cherrapunji (RKM), Beky Rly.Bridge and Bishalgarh 5 each
2 Apr	Sankalan 5
3 Apr	Dharmanagar / Panisagar 7, Belonia, Barpeta and Passighat 6 each, Sonamura, Bhalukpong and Beky Rly. Bridge 5 each
4 Apr	Nil
5 Apr	Jamkhandi, Drf and Annapurnaghat 5 each
6 Apr	Kapkot 6

TABLE 5 (*Contd.*)

Date	Some representative amounts of rainfall in cm for March, April and May 2019 (5 cm and above)
7 Apr	Taibpur 16, Williamnagar 9, Goalpara CWC, Pakuria and Goalpara 8 each, Bahadurganj and Thakurganj 7 each, Mohanpur, Goibargaon, Rampurhat (DRMS) and Gaunaha 6 each, Kakinada, Shillong, Jaleswar, Galgalia, Tiring, Tribeniganj and Bhograi 5 each
8 Apr	Anandpur Sahib 7
9 Apr	Naraingarh 13, Cooch Behar 8,Mathabhanga 7, Munsyari 6, Kishanganj and Chargharia 5 each
10 Apr	Kalyani Smo 7, Sabroom 6, Dunguripalli, Canning Town, Arundhutinagar and N. Lakhimpur 5 each
11 Apr	Thenkasi 8, Shorapur 5
12 Apr	Nil
13 Apr	Damthang 9
14 Apr	Bahadurganj, Tuli Nsdma AWS and Sonbarsa 6 each, Longleng Nsdma AWS and Hasimara 5 each
15 Apr	Daparijo 5
16 Apr	Mathabhanga, Guwahati AWS and Guwahati AP 6 each
17 Apr	Khanpur 7, Shipgyar 6, Tribeni / Balmiki, Mandsaur - AWS and Atru each, Kuzhithurai, Pechiparai, Anta, Arnod, Asnawar, Dug, Drf, Goibargaon, Kodaikanal, Udhampur IAF, Bassi and Sheopur 5 each
18 Apr	Parumbikulam, Dalhousi Alha AWS, Ramannapeta, Budaun, Shipgyar, Fatehgarh Sahib and Sirhind 5 each
19 Apr	Enamakkal and Markapur 8 each, Chintamani PTO and Gaisilet ARG 7 each, Yadagirigutta and Vadakkancherry 6 each, Raikia ARG, Raptadu, Aluva Pwd, Kodungallur and Palakkad 5 each
20 Apr	Parumbikulam, Ambalavayal and Kodaikanal 7 each, Tarva ARG 6, Mavelikara, Konni and Kurudamannil 5 each
21 Apr	Venkatagiri 11, Uthagamandalam 10, Hosur, Maheswaram, Valparai, Omalur and Mettur 7 each, Coonoor, Narmetta, Barur and Srungavarapukota 6 each, Vadakkancherry, Merakamudidam, Kollamkode and Kuppady 5 each
22 Apr	Gangtok 6, Tadong, Kashinagar, Karanjia, Pipili and Thakurmunda 5 each
23 Apr	Attur 10, Mysore 9, Periyakulam, Piravam, Thammampatty, Sankaridurg and Kolar Gold Field 6 each, Kochi AP, Gudalur, Mettur, Tiruvannamalai, Hosur, Kozhikode and Parumbikulam 5 each
24 Apr	Nandigama and Nandigama (ARG) 9 each, Sukinda 7, Kamakhyanagar and Dhanbad 6 each, Keeranur 5
25 Apr	Minicoy 7, Banjar 6
26 Apr	Konni 6
27 Apr	Nil
28 Apr	Karimganj 12, Chengmari/Diana 11, Gharmura 8, Hasimara 7, Kokrajhar 6, B P Ghat 5
29 Apr	Kokrajhar 13, Dhubri 7, Hazuah and Thodupuzha 6 each, Drf and Tikrikilla 5 each
30 Apr	Melabazar/Matunga 16, Drf 14, Cherrapunji 13, Numaligarh 12, Nahar Katia 9, Sivasagar 8, Bihubar, Davanagere PTO and Yelburga 7 each, Naharlagun and Williamnagar 6 each, Dillighat, Khowang, Miao and Majbhat 5 each
1 May	Cherrapunji (RKM) 22, Cherrapunji 20, Mawsynram 16, Goalpara CWC, Haflong and Gossaigaon 10 each, Bargur, Barpeta, Aie NH Xing and Melabazar/Matunga 9 each, Tadong, Hawai and Miao 8 each, Goibargaon, Beky Rly.Bridge, Kokrajhar, Manash NH Xing, Drf, Nalbari/Pagladia and Maya Bandar 7 each, Alipurduar CWC, Alipurduar PTO, Barobhisha, Settur, Tezu, Rolla, Tinsukia, Gowribidanur, Dholla Bazar, Bahalpur and Puthimari 6 each, Panbari, Gangtok, Nongstoin, Kayamkulam Agri, Jorhat, Periyapatna, Alur, Nahar Katia, Karimganj, Neamatighat, Moranhat, Kumargram, Majbhat, C Belagal and Golaghat 5 each
2 May	Tizit Nsdma AWS, Cherrapunji (RKM) and Mawsynram 14 each, Cherrapunji 10, Bahalpur, Nongstoin and Dholla Bazar 9 each, Hawai, Margherita and Tuli Nsdma AWS 8 each, Haflong, Majbhat, Dillighat, Khowang, Tamulpur and Dhubri 7 each, Dhubri CWC, Miao, Konijerla, Manash NH Xing and Tezu 6 each, Bihubar, Goibargaon, Goalpara CWC, Kokrajhar, Moranhat, Puthimari, Drf, Koloriang, Numaligarh, Mathabhanga, Jorhat, Naharlagun, Nahar Katia, Changlang, Barpeta and Itanagar 5 each
3 May	Berhampur 30, Ichchapuram 18, Gopalpur, Sompeta and Banki ARG 17 each, Gossaigaon 16, Chhatrapur and Palasa 15 each, Galgalia 14, Mandasa 13, Mundali and Tekkali 12 each, Purushottampur, Mohana, Puri, Ranpur and R.Udaigiri 11 each, Okrajhar and Rajghat 10 each, Kalingapatnam, Nuagada ARG and Nongstoin 9 each, Digapahandi ARG, Tirtol ARG, Hawai, Balasore and Gania ARG 8 each, Banpur, Alipurduar CWC, Alipurduar PTO, Aska, NH5 Gobindpur, Khandapara, Narsinghpur, Naraj, Niali ARG and Hazuah 7 each, Tangi, Kantapada ARG, Nimpara, Bhubaneshwar AP, Kumargram, Alipingal and Odagaon ARG 6 each, Cooch Behar, Bolagarh ARG, Nayagarh, Daspalla, Long Islands, Ranastalam, Nilgiri, Muniguda ARG, Hindol, Soro and Tikrikilla 5 each

TABLE 5 (*Contd.*)

Date	Some representative amounts of rainfall in cm for March, April and May 2019 (5 cm and above)
4 May	Chandikhol ARG 28, Chandanpur 25, Banki ARG and Balipatna ARG 19 each, Ranpur 17, Bankura CWC, Bhuban ARG, Bhubaneshwar AP, Kantapada ARG and Bangiriposi 16 each, Kalaikunda and Udala 15each, Jaipur, Jenapur, Binjharpur ARG, Kansabati Dam and Samakhunta AWS 14 each, Daitari, Baripada, Betanati ARG, Athgarh, Harinkhola, Cuttack, Phulberia, Raghunathpur ARG, Niali ARG and Jajpur 13 each, Nischintakoili ARG, Hetampur, Hindol, Garadapur ARG, Suri PTO and Remuna ARG 12 each, Tangi, Korei ARG, Bankura, Suri CWC, Kaptipada ARG, Naraj, Akhuapada and Durgapur 11 each, Keongjhargarh, Narsinghpur, Anandpur, Swam -Patna, Rampurhat (DRMS), Sukinda, Ghatagaon, Nongstoin, Bolagarh ARG and Rairangpur 10 each, Nilgiri, Jamsolaghat, Sriniketan, Ghatsila, Messenjor, Tiring, Jhargram PTO, Simula, Kharidwar, Berhampore, Asansol, Arundhutinagar, Jhumpura, Tantloi, Maheshpur and Tuting 9 each, Bonth, Williamnagar, Joda ARG, Midnapore, Sonamura, Midnapore CWC, Asansol CWC, Mohanpur, Dhanbad, Lalgarh, Soro and Tigiria ARG 8 each, Agartala AP, Dhenkanal, Maithon, Mawsynram, Harichandanpur ARG, Tusuma, Joshipur, Tilpara Barrage, Balimundali, Mahanga ARG, Durgachak, Amarpur, Kamalpur, Bagati (Magra), Banpur, Purulia, Bari ARG, Khandapara, Burdwan, Canning Town, Rajmahal, Kolkata, Jarmindi, Moharo, Salepur ARG and Purihansa 7 each, Cherrapunji, Jamshedpur AP, Cherrapunji (RKM), Nh5 Gobindpur, Balasore, Danagadi ARG, Parjang ARG, Chaibasa, Pakuria, Alipingal, Diamond Harbour, Gheropara, Jagatsinghpur AWS, Rajghat, Panchet, Gharmura, Kolkata AP, Champua, Gania ARG, Karanjia, Barmul and Bokaro 6 each, Amfu Kakdwip, Mundali, D. P. Ghat, Angul, Kankadahad ARG, Amfu Majhian, Barrackpur IAF, Kalyani SMO, Derabis ARG, Jamshedpur, Gaunaha, Thakurmunda, Belonia, Nimpara, Makhdumpur, Dumka, Banarpal ARG, Nayagarh, Odagaon ARG, Katoria, Pupunki, Malda, Putki, Bihar Sharif, Digha and Amrapara 5 each
5 May	Cherrapunji (RKM) 41, Mawsynram 33, Cherrapunji 28, Williamnagar 17, Sholingur 14, Shillong and Tamenglongi 13 each, Guwahati City 11, Kheronighat, Sabroom and Barapani 9 each, Guwahati AP, Dharamtul, Barpathar and Kampur 8 each, R. K. Pet, Jia Bharali N T Xing, Bhandari Nsdma AWS, Bokajan, Karimganj, Shella and Numaligarh 7 each, Udaipur, Goibargaon, Tezpur and Ong Pangkong Nsdma AWS 6 each, Dimapur Nsdma AWS, Goalpara, Majbhat, Golaghat, Barpeta, Golaghat CWC, N. Lakhimpur, Naharlagun, Badatighat and Haflong 5 each
6 May	Uthangarai 8, Khliehriat 7, Mangan and Sankalan 6 each, Passighat, Vellore, Panbari, Aie NH Xing, Manash NH Xing, Chungthang, Palasamudram and Chauldhowaghat 5 each
7 May	N. Lakhimpur 9, Dhemaji and Beki Mathungari 7 each, Chauldhowaghat and Naharlagun 6 each, Hazuah, Khanitar, Anini and Tiruppur 5 each
8 May	Tirukoilur 9, Nelamangala 7, Madurai City and Mayanur 6 each, Kancheepuram and Tadong 5 each
9 May	Padalur, Moranhat and Nahar Katia 6 each, Dibrugarh AP, Dholla Bazar and Krishnarajasagara 5 each
10 May	Buxaduar 10, Tezu 9, Cherrapunji and Sivasagar 7 each, Goibargaon, Melabazar/Matunga, Barpeta and Drf 6 each, Moranhat, Manash Nh Xing, Margherita, Gangtok and Cherrapunji (RKM) 5 each
11 May	Cherrapunji (RKM) 15, Cherrapunji 13, Mawsynram 12, Miao 7, Dillighat, Nahar Katia and Manash NH Xing 6 each, Hasimara, Moranhat, Roing, Margherita, Dholla Bazar, Itanagar, Naharlagun and Aie NH Xing 5 each
12 May	Buxaduar 13, Miao 11, Namsai 10, Tinsukia 9, Dholla Bazar 8, Kothagiri, Puthimari and Tezu 7 each, Chinthakam, Dibrugarh AP, Williamnagar, Jaipatna, Koraput, Periyapatna and Kanjirappally 5 each
13 May	Yingkiong 14, Anini and Dholla Bazar 9 each, Miao, Shiv, Namsai and Konni 6 each, Tezu, Passighat and Naharlagun 5 each
14 May	Cherrapunji (RKM) 9, Abhayapuri AWS, Maddur, Beki Mathungari, Tuting and Shoolagiri 6 each, Dumka, Rentachintala, Jangamaheswarapuram and Roing 5 each
15 May	Mawsynram 7, Tibi 6
16 May	Car Nicobar 19, Gharmura 10, Arundhutinagar 7, Dharmanagar / Panisagar, Kandaghat and Silchar 6 each, Williamnagar, Gautam Buddha Nagar, Thakurmunda, Mon Sadar Nsdma AWS, Matijuri and Marandahalli 5 each
17 May	Gossaigaon 7, Gharmura 6, Aie NH Xing, Manash NH Xing, Rangiya and Kokrajhar 5 each
18 May	Kamalpur 10, Dharmanagar/Panisagar and Hissar 7 each, Alipurduar CWC, Alipurduar PTO, Kailashahar, Ghumarwin, Beky Rly. Bridge and Goalpara CWC 6 each, Khowai, Dalhousi Alha AWS, Udhampur IAF, Gundala, Williamnagar and Cherrapunji 5 each
19 May	Koloriang 5
20 May	Yingkiong 7, Dillighat , Chickmagalur and Badatighat 5 each
21 May	Kumargram and Falakata 6 each, Hut Bay 5
22 May	Hakimpet and Cherrapunji 7 each, Pharasgaon, Mokokchang, Goalpara, Alipurduar CWC, Alipurduar PTO, Jamkhandi, Jorhat and Tadong 5 each
23 May	Annapurnaghat 10, Drf and Cherrapunji 8 each, Tezpur, Golaghat, Rajmahal, Jia Bharali N T Xing, Silchar and Gossaigaon 7 each, Mathabhanga, Gaunaha, Goibargaon and Majbhat 6 each, Mawsynram, Melabazar/Matunga, Lakhipur, Dhekiajuli, Golaghat CWC and B P Ghat 5 each

TABLE 5 (*Contd.*)

Date	Some representative amounts of rainfall in cm for March, April and May 2019 (5 cm and above)
24 May	Kailashahar 25, Kolasib 17, Dharmanagar/Panisagar 15, Mangan 10, Gharmura 8, Kabi, Sankalan, Lengpui and Thiruvananthapuram 6 each, Gangtok and Nargund 5 each
25 May	Gyalsing PTO 11, Thiruvananthapuram AP 9, Sabroom, Ramanagara and Thiruvananthapuram 7 each, Kottayam, Lengpui, B P Ghat and Kokrajhar 6 each, Car Nicobar, Hassan, Khowai, Kohima, Tadong, Kozha, Agartala AP, Aie Nh Xing, Lower Kothaiyar ARG, Dharmanagar/Panisagar, Bahalpur and Jharnapani 5 each
26 May	Sankalan 17, Miao 16, Mangan 14, Passighat 10, Dholla Bazar 7, Chungthang 6, Rangiya and Changlang 5 each
27 May	Kamalpur 10, Alipurduar CWC, Alipurduar PTO and Bhalukpong 7 each, Thondebhavi, Gangtok and Jia Bharali N T Xing 6 each, Pedong, G Bazar, Bengaluru Kial, Allagadda, Khowang, Passighat, Badatighat and Gooty 5 each
28 May	Barpeta 9, Beky Rly. Bridge 8, Tamulpur 7, Hazuah, Gangtok and Beki Mathungari 6 each, Tadong, Williamnagar, Nalbari/ Pagladia and Mangan 5 each
29 May	Chengmari /Diana 9, Majitar and Rampurhat (DRMS) 8 each, Nagarkata 7, Gunupur, Dabugan ARG, Kovai/Koyamutthur AP and Murti 6 each, Raikia ARG, Pollachi, Penucondapuram, Sonepur, Mandya, Daringibadi, Ponnani, Khanitar, Mainpur, Gudari and Seethanagaram 5 each
30 May	Raptadu, Rajmahal and Gudalur 9 each, Aryankavu 8, Jagdalpur, Hazuah and Anantpur 6 each, Kursela, Araku Valley, Punalur, Majitar, Damthang and Bonakal 5 each
31 May	Bihpur 8, Dhengbridge 7, Katoria and Usilampatti 6 each, Hosur, Araria, Mulanur, Pochampalli, Bihar Shrif, Majitar and Purnea 5 each

One person was killed and three others injured when a floodlight tower at L. B. Stadium in the heart of Hyderabad collapsed on to the road due to strong winds. Four cars were also crushed under the tower, which brought the traffic in the busy area to a halt. Trees and electricity poles were uprooted, huge hoardings collapsed at a few places, throwing the traffic out of gear. (*v*) A thunderstorm on 15th killed three women in Manipur and injured over 40 people, including 30 students who were injured when a school building in Kwakta, Manipur collapsed. (*vi*) A house in a slum in Indapur, Maharashtra caught fire due to lightning and number of livestocks were burnt to death in the incident. (*vii*) Five people were killed and nine others injured when a landslide induced by heavy rain hit a mini bus in Jammu and Kashmir's Doda district on 19th.

3.3. *May*

3.3.1. *Weather and associated synoptic features*

(a) *Advance of southwest monsoon*

By the middle of May, the cross equatorial flow strengthened over south Andaman Sea. Subsequently, a cyclonic circulation developed over the regions, which led to further deepening of cross equatorial flow and enhanced cloudiness and rainfall over Andaman Sea. Thus, the southwest monsoon advanced into South Andaman Sea, some parts of South Bay of Bengal and Nicobar islands on 18th May. In view of the sustained rainfall activity over Andaman & Nicobar Islands, Southwest Monsoon further advanced into some more parts of southeast Bay of Bengal and north Andaman Sea, remaining parts of Nicobar Islands and southern parts of Andaman Islands on 25th May. In association with further deepening of southwesterlies and increase in rainfall over Andaman Islands, the southwest monsoon further advanced into southernmost parts of Maldives-Comorin area, some more parts of southwest and southeast Bay of Bengal, some parts of eastcentral Bay of Bengal, remaining parts of Andaman Sea and Andaman Islands on 30th May.

(b) *Other synoptic features and rainfall*

The details of weather systems and its track during the month are given in Table 4 and Fig. 2. The principal amounts of rainfall are given in Table 5.

Apart from the Extremely Severe Cyclonic Storm “Fani” which crossed Odisha coast close to Puri as an ESCS with maximum sustained wind speed of 175-185 kmph there was one short lived low-pressure area which formed on 30th May over southwest Arabian Sea off Somalia coast and dissipated on 31st May.

3.3.2. *Temperature distribution*

The minimum temperatures were *normal*/*above normal* on most days over the country with *below normal* temperatures over the northwest India on a few days.

The maximum temperatures remained *normal* to *appreciably above normal* on most days over the country and below normal on few days particularly over

east and northeast India. The day temperatures started rising in the second fortnight over the peninsular region and were markedly above normal by the end of the month.

Severe heat wave conditions prevailed on 1 to 3 days over west Rajasthan, Uttar Pradesh, Vidarbha and Madhya Maharashtra. More frequent *heat waves* were observed over Central India and Peninsular regions also corresponding with the deficient monthly rainfall there. Vidarbha was the most affected subdivision with Severe Heat wave and *Heat wave conditions* prevailing on 29 days.

Incessant flow of dry and hot westerly/northwesterly winds from the deserts in Pakistan and Rajasthan further aided by clear sky conditions led to increased surface heat resulting in intense and longer spells of heat waves.

The month's as well as the season's highest maximum temperature of 49.6 °C was recorded at Ganganagar (west Rajasthan) on 31st May, 2019.

3.3.3. *Disastrous weather events and damage*

Due to ESCS 'Fani', (a) In Odisha, 64 lives, 6,281 cattle were lost, 556,000 houses and huts were damaged, 148,663 hectare of crop land affected, 6,416 boats and 8,828 nets were damaged. Further a total of 222 houses/huts were damaged, 28 cattle were lost and 1,365 hectare crop area was damaged in Andhra Pradesh. (b) In West Bengal, 29,260 houses/huts were damaged and 112,000 hectare of crop area was affected due to the cyclone 'Fani'. To prevent loss of human lives, a record number of 15, 57,170 persons in Odisha, 17,460 persons in Andhra Pradesh and 2,34,801 persons in West Bengal were evacuated to safer places. According to media and other disaster reports, cyclone Fani, in the northeastern states of India triggered heavy to very heavy rainfall activity accompanied with strong winds leaving various parts of the region crippled. It wreaked havoc in Meghalaya as heavy rain initiated landslides in different parts of the state killing one person in east Khasi Hills district due to house collapse. 81 flights had been cancelled across parts of Northeast India. Thunderstorm and rain lashed Chandauli, Sonbhadra and Kushinagar districts of eastern Uttar Pradesh killing seven people injuring eight others late on 1st May, the rain and thunderstorm were an impact of cyclone Fani.

As per media reports, lightning claimed eight persons in two districts of Uttar Pradesh in the first week of May. Heavy rain and gusty winds on the evening of 15th May in Coimbatore district of Tamil Nadu resulted in the death of a 19-year old boy. The teenager was killed by a falling tree. Several incidents of uprooted trees and house damage were reported across the region due to strong and gusty winds. Heavy rain triggered a massive landslide at 14 Mod, near Gulaba, Himachal Pradesh, two thousand tourists were stranded and nearly 600 tourist vehicles were stuck between Gulaba and Marhi, on May 17th. Two girls died while another one was injured critically after they came under a mudslide in Hardi Shiva area of Sopore in north Kashmir's Baramulla district on 22nd May. 739 people were rendered homeless and forced to take shelter in relief camps across Tripura due to heavy rain and thunderstorms. A total of 1,039 houses were damaged due to heavy rainfall. A number of trees and electric posts were also uprooted due to squally winds. The deaths due to heat waves were reported from states like Maharashtra 8 (particularly Vidarbha), Andhra Pradesh 3 (mainly Rayalaseema) and Telangana 22, due to the temperature extremes in these regions. About one hundred and sixty three cases of heat-related illness were reported in Nagpur and 76 cases were reported in Latur region.

Acknowledgment

The inputs received from the office of the Director General of Meteorology (Hydromet), New Delhi is duly acknowledged. Thanks are due to Smt. P. P. Kulkarni and P. N. Chopade for their assistance.

Appendix

Definitions of the terms given in '*Italics*'

Temperatures

Heat Wave	Heat wave is considered if maximum temperature of a station reaches at least 40 °C or more for Plains and at least 30 °C or more for Hilly regions.

(a) *Based on Departure from Normal*

Heat Wave	- Departure from normal is 4.5 °C to 6.4 °C
Severe Heat Wave	- Departure from normal is >6.4 °C

(b) *Based on Actual Maximum Temperature*

Heat Wave	- When actual maximum temperature ≥ 45 °C
Severe Heat Wave	- When actual maximum temperature ≥47 °C

(d) *Criteria for describing Heat Wave for coastal stations*

When maximum temperature departure is 4.5 °C or more from normal, Heat Wave may be described provided actual maximum temperature is 37 °C or more.

Markedly below normal	- - 5.0 °C or less
Appreciably below normal	- - 3.1 °C to –5.0 °C
Below normal	- - 1.6 °C to 3.0 °C
Normal	- - 1.5 °C to 1.5 °C
Above normal	- 1.6 °C to 3.0 °C
Appreciably above normal	- 3.1 °C to 5.0 °C
Markedly above normal	- 5.0 °C or more

Rainfall	
Heavy	- 64.5 to 115.5 mm
Very Heavy	- 115.6 to 204.4 mm
Extremely Heavy	- ≥204.5 mm
Large Excess	- Percentage departure from normal rainfall is + 60% or more
Excess	- Percentage departure from normal rainfall is + 20% to +59%
Normal	- Percentage departure from normal rainfall is +19% to –19%
Deficient	- Percentage departure from normal rainfall is –20% to –59%
Large Deficient	- Percentage departure from normal rainfall is –60% or less
No rain	- –100%