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Weather in India

WINTER SEASON (January-February 2019)†

1. Introduction

The winter season 2019, comprising January and February, witnessed prolonged below normal night temperatures and cold waves affecting parts of northwest India. Over the remaining parts, the winter in general had been mild in terms of temperature, except for a brief spell of *severe cold wave*/*cold wave* and *cold day** occurrences.

A persistent change in the wind pattern replaced maritime air over the southern Peninsular India by dry continental air, marking the conclusion of the northeast monsoon rains over Tamil Nadu and Puducherry, Kerala, adjoining parts of Andhra Pradesh and Karnataka from 2nd January, 2019.

During the month of February, frequent and active western disturbances incurred significant moisture from the Arabian Sea, resulting in a substantial increase in the winter rains, especially in the later part of the season making it a wetter than normal February in northwest and northeast india.

The core of Sub-Tropical Westerly Jet (STWJ) was seen between Latitude 21° N and 34° N all through the season, allowing the systems in westerlies to traverse along more southern latitudes.

Dense to very dense Fog was observed over parts of northern plains on many days and isolated events over the rest of the regions throughout the season.

Other than the Cyclonic Storm 'PABUK' over Andaman Sea and neighbourhood, one Low pressure area over the equatorial Indian Ocean and adjoining central parts of south Bay of Bengal formed during January. Four induced low pressure areas formed in the westerly wind regime, in the month of February.

2. Seasonal Rainfall (January-February)

Rainfall during the season over the country as a whole was 126% of LPA and third highest since 2001, (First being 2005, followed by 2003).

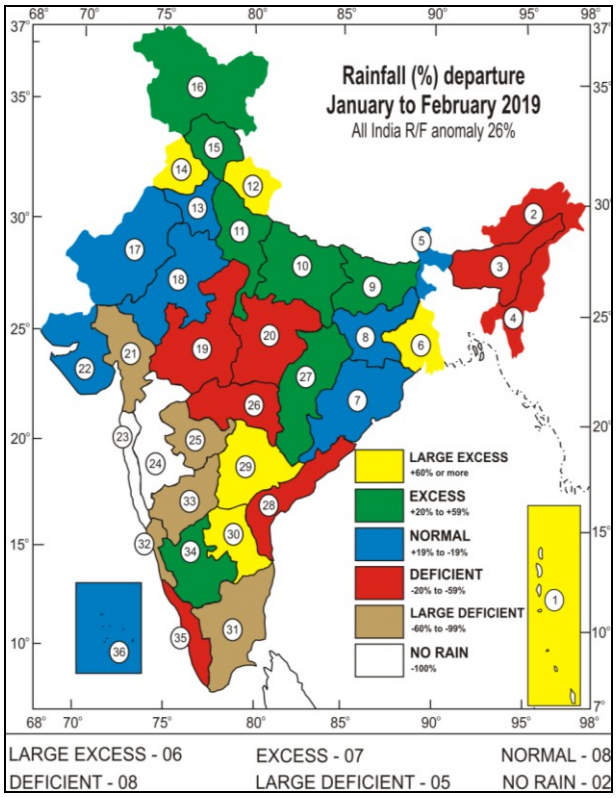

Fig. 1. Sub-divisionwise rainfall percentage departures for the season Jan-Feb, 2019. Sub-divisions are indicated by number on the map & bold letters in legend. The rainfall anomaly values for these 36 sub-divisions are indicated below :

1	138	**7**	-17	**13**	6	**19**	-47	**25**	-95	**31**	-83
2	-35	**8**	-9	**14**	108	**20**	-38	**26**	-31	**32**	-89
3	-38	**9**	53	**15**	45	**21**	-75	**27**	21	**33**	-85
4	-25	**10**	31	**16**	58	**22**	18	**28**	-47	**34**	46
5	-12	**11**	49	**17**	-19	**23**	-100	**29**	71	**35**	-42
6	174	**12**	99	**18**	-18	**24**	-100	**30**	73	**36**	12

More frequent and intense western disturbances affected Northwest India causing widespread precipitation over the region (+57% anomaly) making it the second highest rainy season since 2001. In both the months, the precipitation was above normal in the northwest region with January being *normal* and February excess. Subdued easterly activity and due to near absence of interaction of the western disturbances with the systems in easterlies, the rainfall mostly in major parts of the country outside northwest India remained *normal* or *deficient** during the season.

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

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TABLE 1

Sub-divisionwise rainfall (mm) for each month and season as a whole (January-February, 2019)

S. No.	Meteorological Sub-divisions	January			February			Season		
		Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)
1.	A. & N. Islands	173.8	51.6	237	5.8	23.8	-76	179.6	75.4	138
2.	Arunachal Pradesh	10.8	47.2	-77	87.2	99.5	-12	95.7	146.7	-35
3.	Assam & Meghalaya	2.5	15.5	-84	26.3	31.2	-16	28.9	46.7	-38
4.	Naga., Mani., Mizo. and Tri.	3.5	12.1	-71	24.7	25.7	-4	28.2	37.8	-25
5.	Sub-Himalayan West Bengal & Sikkim	4.4	16.0	-73	36.0	29.9	20	40.4	45.9	-12
6.	Gangetic West Bengal	0.0	12.4	-99	90.0	20.4	341	90.0	32.8	174
7.	Orissa	1.3	12.1	-89	22.9	17.1	34	24.2	29.2	-17
8.	Jharkhand	0.9	12.2	-92	24.6	16.0	54	25.6	28.2	-9
9.	Bihar	5.1	10.0	-49	25.7	10.1	154	30.8	20.1	53
10.	East Uttar Pradesh	11.6	12.2	-5	21.9	13.3	64	33.5	25.5	31
11.	West Uttar Pradesh	16.4	12.3	33	27.0	17.0	59	43.8	29.3	49
12.	Uttarakhand	76.3	41.6	83	125.4	59.8	110	201.8	101.4	99
13.	Haryana, Chandigarh & Delhi	15.2	14.3	7	17.4	16.6	5	32.7	30.9	6
14.	Punjab	28.1	21.0	34	73.1	27.7	164	101.2	48.7	108
15.	Himachal Pradesh	84.7	89.9	-6	194.7	102.8	89	279.3	192.7	45
16.	Jammu & Kashmir	140.0	94.1	49	216.9	131.5	65	356.9	225.6	58
17.	West Rajasthan	5.5	2.9	88	1.7	5.9	-72	7.1	8.8	-19
18.	East Rajasthan	5.4	4.4	23	2.8	5.6	-50	8.2	10.0	-18
19.	West Madhya Pradesh	1.2	6.6	-82	5.5	5.9	7	6.6	12.5	-47
20.	East Madhya Pradesh	11.8	16.0	-26	8.7	16.9	-49	20.5	32.9	-38
21.	Gujarat region	0.0	1.0	-100	0.4	0.5	-25	0.4	1.5	-75
22.	Saurashtra & Kutch	0.9	0.4	128	0.3	0.6	-55	1.2	1.0	18
23.	Konkan & Goa	0.0	0.5	-100	0.0	0.2	-100.0	0.0	0.7	-100
24.	Madhya Maharashtra	0.0	1.6	-100	0.0	1.3	-100.0	0.0	2.9	-100
25.	Marathawada	0.0	4.4	-100	0.3	2.5	-87	0.3	6.9	-95
26.	Vidarbha	10.9	10.1	8	1.3	7.7	-83	12.3	17.8	-31
27.	Chattisgarh	14.9	11.1	34	10.9	10.2	7	25.8	21.3	21
28.	Coastal Andhra Pradesh	10.4	9.7	8	1.5	12.7	-89.0	11.9	22.4	-47
29.	Telangana	23.2	7.7	201	1.5	6.7	-78	24.6	14.4	71
30.	Rayalaseema	13.1	3.6	263	0.9	4.5	-79.0	14.0	8.1	73
31.	Tamil Nadu	2.1	15.4	-86	2.7	12.5	-79.0	4.8	27.9	-83
32.	Coastal Karnataka	0.0	1.7	-100	0.3	0.8	64	0.3	2.5	-89
33.	North interior Karnataka	0.8	3.0	-75	0.0	2.2	-98.0	0.8	5.2	-85
34.	South interior Karnataka	1.1	2.2	-52	7.4	3.6	106.0	8.5	5.8	46
35.	Kerala	0.7	8.4	-92	12.4	14.0	-11	13.1	22.4	-42
36.	Lakshadweep	0.0	15.4	-100	28.1	9.8	187	28.1	25.2	12

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

TABLE 2

Details of the weather systems during January 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.	Cyclonic storm 'PABUK'	4-8	Gulf of Thailand near Lat. 8.3° N / Long. 101.0° E	Northwest	Southeast Bay of Bengal close to Andaman Islands near Lat. 12.6° N/ Long. 92.0° E	It lay initially over south China Sea. Details are given in the article on Storms & Depressions over the north Indian Ocean 2019
2.	Low pressure	21-25	Equatorial Indian Ocean and adjoining central parts of south Bay of Bengal	Southeast	Equatorial Indian Ocean and adjoining southeast Bay of Bengal	It initially lay as a trough of low at mean sea level over south Andaman Sea and adjoining areas of southeast Bay of Bengal and equatorial Indian Ocean from 18-20. It became unimportant on 26
(**B**)	*Western disturbances /eastward moving systems*					
(*i*)	*Upper air cyclonic circulation*					
1.	Upto 3.6 kms above m.s.l.	3-6	Iran and neighborhood	Northeast wards	Northeast Jammu and Kashmir	Moved away northeastwards on 6 evening. The trough aloft in mid & upper tropospheric westerlies remained from 4-10
2.	At 3.1 kms above m.s.l.	7-10	Northeast Afghanistan and neighbourhood	Northeast	Jammu and Kashmir and neighbourhood	Moved away northeastwards
3.	At 3.1 km a.s.l.	11-13	Afghanistan and adjoining central Pakistan	Eastnorth-east	Jammu & Kashmir and adjoining north Pakistan	Moved away northeastwards
4.	Do	15-16	Northeast Afghanistan & neighbourhood	Do	Eastern parts of Jammu & Kashmir	Moved away northeastwards
5.	Do	18-23	Iran and neighbourhood	Do	North Pakistan and adjoining Jammu & Kashmir	A trough aloft with its axis at 5.8 kms above m.s.l. running roughly along Long. 50° E to the north of Lat. 30° N. Moved away east northeast wards
6.	Mid & upper troposphere	24-27	North Pakistan and adjoining Jammu & Kashmir	East	Jammu & Kashmir and neighbourhood	It initially lay as a trough roughly along Long. 65° E to the north of Lat. 30° N on 23 evening with its axis at 5.8 kms above m.s.l. Moved away northeastwards
7.	Between 3.1 & 5.8 kms above m.s.l.	29 Jan - 2 Feb	Iran & neighborhood	Northeast	North Pakistan and adjoining Punjab and Jammu & Kashmir	Moved away northeastwards
(*ii*)	*As a trough*					
1.	Mid & upper tropospheric westerlies with its axis at 5.8 kms above m.s.l.	10-15	Roughly along Long. 52° E to the north of Lat. 32° N	East	Roughly along Long. 93° E to the north of Lat. 28° N	Moved away eastwards

TABLE 2 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.	Lower & mid tropospheric westerlies with its axis at 5.8 kms above m.s.l.	15-17	Roughly along Long. 66° E to the north of Lat. 30° N	Northeast	Long. 80° E to the north of Lat. 30° N	Became less marked on 18
3.	At 3.1 kms above m.s.l.	18	Roughly along Long. 93° E to the north of Lat. 25° N	Do	-	Moved away northeast wards
(*iii*)	*As induced cyclonic circulation*					
1.	Between 0.9 & 2.1 kms above m.s.l.	4-6	South Pakistan and adjoining west Rajasthan	Northeast	Haryana and adjoining Punjab-north Rajasthan	Became less marked on 7
2.	Upto 0.9 km above m.s.l.	11-13	West Rajasthan & neighbourhood	Do	Northeast Rajasthan and neighbourhood	Became less marked on 14
3.	Between 1.5 & 2.1 kms above m.s.l.	16	Punjab & adjoining central Pakistan	Stationary	*In situ*	Became less marked on 17
4.	Upto 1.5 km above m.s.l.	19-21	West Rajasthan and adjoining entral Pakistan	East	West Rajasthan and neighbourhood	Became less marked on 22
5.	Up to 0.9 km above m.s.l.	30 Jan - 1 Feb	South Pakistan & neighbourhood	Northeast	Northwest Rajasthan and neighbourhood	Became less marked on 2 Feb
(C)	*Other upper air cyclonic circulations*					
1.	Between 1.5 & 2.1 kms above m.s.l.	1	Kerala and adjoining southeast Arabian Sea	Stationary	*In situ*	Became less marked on 2
2.	Do	2	Comorin area and neighborhood on 2	Do	Do	Became less marked on 3
3.	At 0.9 km a.s.l.	6-7	Southwest Uttar Pradesh & neighbourhood	East	Southeast Uttar Pradesh & neighbourhood	Became less marked on 8
4.	At 1.5 kms above m.s.l.	10	Comorin area and neighbourhood	Stationary	*In situ*	Became less marked on 11
5.	At 0.9 km above m.s.l.	16	South Kerala and neighbourhood	Do	Do	Became less marked on 17
6.	Upto 3.1 km a.s.l.	17-22	Bangladesh and neighbourhood	East	Mizoram Tripura neighbourhood	Moved away eastwards
7.	Upto 0.9 km a.s.l.	19	Coastal Karnataka and neighbourhood	Stationary	*In situ*	Became less marked on 20
8.	Do	23	Southwest Bay of Bengal off north Tamil Nadu	Do	Do	Became less marked on 24
9.	Do	23-24	Southeast Uttar Pradesh & neighbourhood	North	Northeast Uttar Pradesh & neighbourhood	Became less marked on 25
10.	At 1.5 km a.s.l.	24-26	Southwest Madhya Pradesh and neighbourhood	South	Eastern parts of Vidarbha and neighbourhood	Became less marked on 27
11.	Upto 0.9 km a.s.l.	25	South Madhya Maharashtra & neighborhood	Stationary	*In situ*	Became less marked on 27
12.	Upto 1.5 km a.s.l.	25-27	South Assam & neighborhood	North	Central Assam and neighbourhood	It lay as a trough in westerlies between 1.5 & 2.1 kms above m.s.l. running roughly along Long. 93° E to the north of Lat. 26° N on 28. It became less marked on 29
13.	Upto 0.9 km a.s.l.	26	South interior Karnataka & neighborhood	Stationary	*In situ*	Became less marked on 27

TABLE 2 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
14.	Upto 1.5 km a.s.l.	26-30	Eastcentral Arabian Sea off south Maharashtra-Goa coasts	West	East central and adjoining southeast Arabian Sea	Unimportant on 31
15.	At 1.5 km a.s.l.	30	Central parts of Konkan and adjoining Madhya Maharashtra	Stationary	*In situ*	Became less marked on 31
16.	Between 2.1 & 3.6 km a.s.l.	31 Jan - 1 Feb	Lakshadweep area & neighbourhood	Do	Do	Became less marked on 2 Feb
(D)	*Trough in easterlies*					
1.	Upto 0.9 km a.s.l.	6	From Maldives area to south Interior Karnataka	Stationary	*In situ*	Became less marked on 7
2.	Do	14-15	From Comorin-Maldives area to north Interior Karnataka across north Kerala & south Interior Karnataka	West	From Maldives area to southeast Arabian Sea off Karnataka coast	Became less marked on 16
3.	At 0.9 km above m.s.l.	18	From Maldives-Lakshadweep area to east central Arabian Sea off Karnataka coast	Stationary	*In situ*	Became less marked on 19
4.	Upto 0.9 km a.s.l.	27-28	From Comorin area to north Interior Karnataka across interior Tamil Nadu & south Interior Karnataka	West	Lakshadweep area to south interior Karnataka across Kerala	Became less marked on 29
(E)	*Other troughs*					
1.	Upto 0.9 km a.s.l.	11-13	From coastal Karnataka to southwest Madhya Pradesh across north interior Karnataka, Marathawada and Vidarbha on 11	Oscillatory	From north interior Karnataka to Madhya Maharashtra	Became less marked on 14
2.	Between 0.9 & 1.5 kms above m.s.l.	22	A north-south trough ran from northwest Rajasthan to Marathwada across west Madhya Pradesh	Stationary	*In situ*	Became less marked on 23
3.	At 0.9 km above m.s.l.	23-24	From cyclonic circulation over Southwest Bay of Bengal to Telangana across Rayalaseema	West	Southwest Bay of Bengal and adjoining Sri Lanka	Became less marked on 25
4.	At 1.5 km a.s.l.	25-26	From the cyclonic circulation over south Madhya Pradesh and neighbourhood to south Interior Karnataka across Madhya Maharashtra and north interior Karnataka	East	From the cyclonic circulation upto north interior Karnataka	Became less marked on 27
5.	Do	27-28	From southeast Uttar Pradesh to south Chhattisgarh	Stationary	*In situ*	Became less marked on 29
6.	At mean sea level	27-29	From Southeast Bay of Bengal, adjoining Andaman Sea & Equatorial Indian Ocean	West	From Equatorial Indian Ocean and adjoining areas of Andaman sea and southeast Bay of Bengal	Became less marked on 30
7.	At 0.9 km a.s.l.	31	From south interior Karnataka to Marathwada across north interior Karnataka	Stationary	*In situ*	Became less marked on 1 Feb

The monthly and seasonal sub-division rainfall (actual, normal and percentage departure) are given in Table 1. Also representative amounts of rainfall on a day-to-day basis are given in Table 4. Out of the 36 met-sub-divisions of India, the seasonal rainfall was *large excess* in 6; *excess* in 7, *normal* in 8, *deficient* in 8, *large deficient* in 5 and *no rain* in 2 sub-divisions. The percentage departures falling under various categories *viz*., *large excess*, *excess, normal, deficient, large deficient* and *no rain* are shown in Fig. 1.

3. Monthly features

3.1. *January*

3.1.1. *Storms and Depressions*

Cyclonic Storm 'PABUK' from Gulf of Thailand emerged into Andaman Sea and neighbourhood on 5th January. It became the first cyclonic storm over Andaman Sea in the month of January in the satellite era (1961 onwards). This system caused widespread rainfall activity over Andaman and Nicobar Islands for about three days with heavy rainfall on one day.

Besides this cyclonic storm, a low pressure area formed over the equatorial Indian Ocean and adjoining central parts of south of Bay of Bengal during 21-25 January and became unimportant on 26th. This system too resulted in widespread rainfall over Andaman & Nicobar Islands with heavy rainfall at isolated places on one day.

3.1.2. *Weather and associated synoptic features*

As given in Table 2, 15 western disturbances (including 7 upper air cyclonic circulations, 3 troughs in westerlies and 5 induced cyclonic circulations), 16 upper air cyclonic circulations, 4 troughs in easterlies and 7 other troughs formed which affected the weather over the country during the month of January.

3.1.3. *Monthly rainfall*

In the first fortnight of the month the rainfall over the country remained deficient at -58% of LPA and Andaman and Nicobar Islands was the only sub-division getting Large excess rainfall under the influence of the Cyclonic storm "PABUK". The high index phase of mid-latitude circulation regime and subdued tropical easterly waves over the Indian Seas caused the remaining parts of mainland outside western Himalayan region to remain subdued or devoid of rainfall.

In the second half of the month two western disturbances in quick succession caused widespread precipitation over northwest India. The western disturbances, easterly waves, occasional interaction between easterlies and westerlies triggered scattered to fairly widespread rain/thundershower activity over parts of central and east India and also over south peninsular India in the last week of the month. The rainfall for the month was above normal over northwest India (138% of its LPA), South Peninsular India (121% of its LPA) and was d*eficient* over Central India (-37% of its LPA) and *large deficient* over East and Northeast India (-78% *i.e.*, it recorded rainfall only 22% of LPA); all sub-divisions in this region remained *large deficient* except Bihar which was *deficient*.

Out of the 36 met-sub-divisions of India, the month's rainfall was *large/excess* in 6, *excess* in 5, *normal* in 5, *deficient* in 3, *large deficient* in 11 sub-divisions and *no rain* in 6 sub-divisions (Gujarat, Konkan & Goa, Madhya Maharashtra, Marathwada, Coastal Karnataka and Lakshadweep Islands). During the month, rainfall realized over sub-divisions of Andaman & Nicobar Islands, Vidarbha, Chhattisgarh, coastal Andhra Pradesh & Yanam, Telangana, Rayalaseema and all sub-divisions from northwestern region received *large excess*/*excess*/*normal* rainfall. Telangana and Rayalaseema sub-divisions recorded rainfall more than four times that of normal rainfall for the month.

3.1.4. *Temperature*

The year began with *cold wave* conditions in some parts over Punjab, Haryana, Chandigarh, Delhi, Madhya Maharashtra, East Madhya Pradesh and at isolated pockets over east Rajasthan, Uttar Pradesh, Bihar, Chhattisgarh, Marathwada, Telangana, north Interior Karnataka and Vidarbha. Isolated cold wave conditions were observed at few places in Punjab, Haryana, Chattisgarh, Odisha, Madhya Maharashtra, Vidarbha, Madhya Pradesh, Telangana and Nagaland, Manipur and Mizoram on one to six days in the month. *Cold day* conditions were observed in the last week of the month at isolated places over East Madhya Pradesh and Vidarbha on 30th and 31st January.

Severe cold wave conditions prevailed at isolated places over Punjab on 1st and then from 29 to 31, over Gangetic west Bengal, Telangana, Madhya Pradesh, Chattisgarh, Odisha and Vidarbha.

In the first fortnight of the month, the maximum temperatures were *normal or above normal* over most of the sub-divisions except the northwest sub-divisions where the temperatures were below normal in correspondence with the passing of western disturbances. The day temperatures remained *above* to *appreciably above normal* on most days of the month in the northeast region due to cloudless skies because of an anomalous

TABLE 3

Details of the weather systems during February 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/Eastward moving systems*					
(*i*)	*Upper air cyclonic circulation*					
1.	Between 3.1 & 5.8 km a.s.l.	5-8	West Iran & neighbourhood	East	North Pakistan and adjoining Jammu & Kashmir	It lay as a trough aloft with its axis at 5.8 km a.s.l. and along Long. 55° E and to the north of Lat. 26° N on 4 and then as a cyclonic circulation over Afghanistan & neighbourhood between 3.1 & 7.6 km a.s.l. from 5 to 8. The WD lay as a trough in mid and upper tropospheric westerlies on 9 & moved away northeastwards on 11
2.	At 3.1 km a.s.l.	10	Jammu & Kashmir and neighbourhood	Stationary	*In situ*	It moved away east northeastwards on 11
3.	Between 3.1 & 3.6 km a.s.l.	11-13	Western parts of Afghanistan and neighbourhood	East	Northern parts of Jammu & Kashmir and neighbourhood	It moved away east northeastwards on 14
4.	Upto 4.5 km a.s.l.	12-15	Iran and neighbourhood	Do	North Pakistan and adjoining Jammu & Kashmir	A trough aloft with its axis at 5.8 km a.s.l. and along Long. 50° E and to the north of Lat. 30° N on 12. The remnant of WD as a trough ran roughly along Long. 76° E and north of Lat. 28° N on 16. Moved away north eastwards on 18. WD moved away northeastwards on 16
5.	At 3.1 km a.s.l.	17-18	Central Pakistan and neighbourhood	Do	Eastern parts of Jammu & Kashmir and neighbourhood	It moved away northeastwards on 19
6.	At 5.8 km a.s.l.	24	Do	Do	Northeastern parts of Jammu & neighbourhood	It initially lay as a trough in mid tropospheric westerlies with axis at 5.8 km a.s.l. on 23. Trough aloft at 5.8 km a.s.l. during 24-25 & moved away northeastwards on 26. WD as a cyclonic circulation moved away east northeastwards on 28
7.	Do	25-26	Afghanistan and neighbourhood	Do	East Afghanistan and neighbourhood	WD as a cyclonic circulation became less marked on 27. Trough aloft in mid tropospheric westerlies with axis at 5.8 km a.s.l. during 26-28 and moved away east northeastwards on 1 March
(*ii*)	*As trough in westerlies*					
1.	At 3.1 km a.s.l.	5-7	From the WD as a cyclonic circulation over Afghanistan and neighbourhood to north Arabian Sea to the north of Lat. 26° N	East	Afghanistan & neighbourhood to east central Arabian sea (north of Lat. 15° N)	Merged with the WD as a cyclonic circulation over north Pakistan & adjoining Jammu & Kashmir on 8 evening

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.	At 5.8 km a.s.l.	17-19	Along Long. 56° E to the north of Lat. 32° N	East	Jammu & Kashmir and adjoining Pakistan	It lay as a cyclonic circulation at 3.1 km a.s.l. over Jammu & Kashmir and adjoining Pakistan on 20. Moved away on 21
3.	Do	19-21	Along Long. 55° E to the north of Lat. 30° N	Do	East Afghanistan and neighbourhood as a cyclonic circulation	Cyclonic circulation became less marked on 22. Trough at 5.8 km a.s.l. runs roughly along Long. 72° E to the north of Lat. 32° N. Moved away on 23
4.	At 3.1 km a.s.l.	28	Along Long. 56° E to the north of Lat. 32° N	Stationary	*In situ*	Merged with a Western Disturbance lay as a cyclonic circulation lies over east Afghanistan & neighbourhood on 1 March
(*iii*)	*As an Induced Low*					
1.	At mean sea level	7(1430)-7(1730)	Northwest Rajasthan and neighbourhood	East	Northeast Rajasthan and adjoining areas of Haryana and west Uttar Pradesh	Became less marked on 8
2.	Do	14	Do	Stationary	*In situ*	It formed under the influence of induced cyclonic circulation oversouth Pakistan and neighbourhood. Became less marked on 15. The associated cyclonic circulation over northwest Rajasthan and neighbourhood lay over east Rajasthan and adjoining northwest Madhya Pradesh and extended upto 1.5 kms above m.s.l. on 15. It lay as a cyclonic circulation over northeast Uttar Pradesh and neighbourhood at 1.5 kms above m.s.l. on 16 and became less marked on 17
3.	Do	18	Northwest Rajasthan and adjoining Pakistan	Do	Do	Associated cyclonic circulation extends upto 0.9 km. Became less marked on 19
4.	Do	19	Southwest Rajasthan & neighbourhood	Do	Do	Became less marked on 20. However associated cyclonic circulation lay as an induced cyclonic circulation over northwest Rajasthan and adjoining Punjab and Haryana
(*iv*)	*Cyclonic circulation*					
1.	Upto 1.5 km a.s.l.	5-7	Southwest Rajasthan & neighbourhood	East	North Rajasthan and neighbourhood	A trough extended upto at 0.9 km from the induced cyclonic circulation over north Rajasthan and neighbourhood to East Madhya Pradesh across northwest Madhya Pradesh on 7. Both the systems became less marked on 8
2.	Upto 0.9 km a.s.l.	26-27	Do	Northeast	East Rajasthan and neighbourhood	Became less marked on 28
(**B**)	*Other upper air cyclonic circulations*					
1.	Upto 0.9 km a.s.l.	1	Coastal Karnataka & neighbourhood	Stationary	*In situ*	Merged with the trough ran from coastal Karnataka to Punjab on 2

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.	At 1.5 km a.s.l	2-3	North Rajasthan & adjoining Haryana	East	Haryana & neighbourhood	Became less marked on 4
3.	Do	3	South Assam and neighbourhood	Stationary	*In situ*	Became less marked on 4
4.	At 0.9 km a.s.l.	5-6	South Interior Karnataka and neighbourhood	Do	Do	Became less marked on 7
5.	Upto 0.9 km a.s.l.	6-7	Southeast Rajasthan and adjoining Gujarat	Do	Do	Became less marked on 8
6.	Upto 1.5 km a.s.l.	7-9	Bihar and neighbourhood	South	North Chattisgarh and adjoining areas of Jharkhand & Odisha	Became less marked on 10
7.	Do	8	Haryana and neighbourhood	Stationary	*In situ*	Became less marked on 9
8.	Between 0.9 & 1.5 km a.s.l.	11-16	Bangladesh and neighbourhood	North	Sub-Himalayan west Bengal and adjoining west Assam	Became less marked on 17
9.	Upto 0.9 km a.s.l	11-12	Eastcentral Arabian Sea and adjoining Konkan	South	Eastcentral Arabian Sea off Karnataka coast	Became less marked on 13
10.	Between 1.5 & 2.1 km a.s.l.	12	South Haryana and neighbourhood	Stationary	*In situ*	Became less marked on 13
11.	At 0.9 km a.s.l.	15	South Tamilnadu and neighbourhood	Do	Do	Merged with the trough ran from Gulf of Mannar to Telangana on 16
12.	Upto 1.5 km a.s.l.	16	Marathwada and neighbourhood	Do	Do	Became less marked on 17
13.	At 0.9 km a.s.l.	17	Interior Odisha and neighbourhood	Do	Do	Became less marked on 18
14.	Do	17-18	Telangana and neighbourhood	East	South Andhra Pradesh and neighbourhood	Became less marked on 19
15.	At 1.5 km a.s.l.	18	Interior Tamilnadu and neighbourhood	Stationary	*In situ*	Became less marked on 19
16.	Between 0.9 & 1.5 km a.s.l.	18-20	East Assam and neighbourhood	Do	Do	It became less marked on 21
17.	At 1.5 km a.s.l.	19	Punjab and neighbourhood	Do	Do	It merged with the cyclonic circulation over Jammu & Kashmir and adjoining Pakistan on 20
18.	Upto 1.5 km a.s.l.	19	Eastcentral Arabian Sea & adjoining Karnataka coast	Do	Do	Became less marked on 20
19.	At 0 .9 km a.s.l.	21	Madhya Pradesh and neighbourhood	Do	Do	Became less marked on 22
20.	Upto 1.5 km a.s.l	21-23	Bangladesh and neighbourhood	East	East Assam and neighbourhood	Became less marked on 24
21.	At 1.5 km a.s.l	21	Eastcentral Arabian Sea off Karnataka coast	Stationary	*In situ*	Became less marked on 22
22.	At 0 .9 km a.s.l.	23	Eastern parts of Bihar & adjoining Sub-Himalayan West Bengal	Do	Do	It lay as a trough at 1.5 km a.s.l. on 24 and became less marked on 25
23.	Do	25	East Rajasthan and neighbourhood	Do	Do	Became less marked on 26
24.	Do	25	Northeast Madhya Pradesh and neighbourhood	Do	Do	Became less marked on 26

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
25.	Upto 1.5 km a.s.l.	27	Central parts of Assam and neighbourhood	Stationary	*In situ*	Became less marked on 28
26.	At 0 .9 km a.s.l.	28	Bangladesh and neighbourhood	Do	Do	Became less marked on 1 March
(**C**)	*Trough in easterlies*					
1.	Upto 0.9 km a.s.l.	1-3	Coastal Karnataka to Punjab	West	Maldives area to eastcentral Arabian Sea off Karnataka coast	Became less marked on 4
2.	Do	8-9	Maldives area to Telangana	East	Comorin area to coastal Andhra Pradesh	Became less marked on 10
3.	At 0.9 km a.s.l.	16	Gulf of Mannar to Telangana	Stationary	*In situ*	Became less marked on 17
4.	Do	21-22	Comorin area to north Interior Karnataka	North	Maldives area to north Interior Karnataka	Became less marked on 23
(**D**)	*Other troughs/Wind discontinuity*					
1.	At mean sea level	2	Central parts of south Bay of Bengal & adjoining Equatorial Indian ocean	Stationary	*In situ*	Became less marked on 3
2.	Do	4-7	Southwest Bay of Bengal & adjoining Equatorial Indian ocean off Sri Lanka coast	South	Maldives area to coastal Karnataka	Embedded cyclonic circulation over southeast Arabian Sea and adjoining south Kerala & extended upto 0.9 km a.s.l. on 6 and became less marked on 7. Trough of low became less marked on 8
3.	Do	7	Northwest Rajasthan and neighbourhood (1430 hrs IST)	East	Northeast Rajasthan & adjoining areas of Haryana & west Uttar Pradesh (1730 hrs IST)	Associated cyclonic circulation extended upto 1.5 km a.s.l. and became less marked on 8
4.	Do	13-15	Maldives Comorin area to eastcentral Arabian Sea off south Maharashtra coast	Do	Maldives area to Madhya Maharashtra	Initially trough in easterlies ran from Maldives Comorin area to southeast Arabian Sea off Kerala coast during 10-12 It became less marked on 16
5.	At 0.9 km a.s.l.	15	Northwest Rajasthan to north Interior Karnataka	Stationary	*In situ*	Became less marked on 16
6.	Do	17-18	Telangana & neighbourhood to Comorin area	East	South Andhra Pradesh & neighbourhood to Comorin area	Became less marked on 19
7.	Do	19	Northwest Uttar Pradesh to west Vidarbha	Stationary	*In situ*	Became less marked on 20
8.	Upto 0.9 km a.s.l.	20	Northwest Rajasthan and adjoining Punjab & Haryana to western parts of Vidarbha	Do	Do	Became less marked on 21
9.	At 0.9 km a.s.l.	23	South Chattisgarh to north Interior Karnataka	East	Interior Odisha to eastcentral Arabian Sea	Became less marked on 25
10.	At mean sea level	24-28	Equatorial Indian ocean and adjoining central parts of south Bay of Bengal	West	Equatorial Indian ocean and adjoining comorin area	Became less marked on 1 March
11.	Upto 1.5 km a.s.l.	25-26	East Bihar to north Odisha	East	East Bihar to Gangetic west Bengal	Became less marked on 27
12.	At 0.9 km a.s.l.	26	Interior Odisha to north Interior Karnataka	Stationary	*In situ*	Became less marked on 27

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
13.	At 1.5 km a.s.l.	26-27	Haryana to northeast Madhya Pradesh	South	East Rajasthan & neighbourhood to north Chattisgarh	Became less marked on 28
14.	At 0.9 km a.s.l.	27-28	North Interior Karnataka to Comorin area	East	Interior Odisha to south Tamilnadu	Became less marked on 1 March
(**E**)	*East-west shear zone*					
1.	At 5.8 km a.s.l.	13	Along Lat. 10° N	Stationary	*In situ*	Eastwest shear zone became less marked on 14

anticyclone over the region in the lower levels. There was a rise in both day & night temperatures between 20-28 January when they were *above normal* to *appreciably above normal* over all the north and northwest sub-divisions, which can be attributed to prevalence of easterly and southeasterly winds. The last few days of the month saw a drop in maximum and minimum temperatures over most parts of the country with *markedly below normal* temperatures over east Rajasthan, Madhya Pradesh, Chattisgarh, Gangetic West Bengal, Bihar, Odisha, Jharkhand, Marathwada, Vidarbha and Telangana. Interaction between easterlies and westerlies caused scattered to fairly widespread rain/thundershower activity over parts of central, east India and also over south peninsular India and aided in bringing down the temperatures.

The minimum temperatures were *normal to below normal* over most days of the month and the season's lowest minimum temperature over the plains of the country was -1.1 °C recorded at Churu (West Rajasthan) on 29th January.

3.1.5. *Damages associated with Disastrous weather events*

According to press and media reports ten people were killed due to an avalanche in Ladakh's Khardungla pass area. The avalanche was triggered by digging of snow on 18th January. Snowfall in most parts of Kashmir disrupted flight operations on a few days. The snowfall led to cancellation of flights and delays. Trains were delayed and several flights diverted due to a dense fog cover over the national capital, New Delhi, causing visibility to remain zero for a few hours on 18th January.

3.2. *February*

3.2.1. *Storms and Depressions*

No intense system formed over the Indian Seas during the month.

3.2.2. *Other synoptic features and associated weather*

As given in Table 3, 17 western disturbances (including 7 upper air cyclonic circulations, 4 troughs in westerlies and 6 induced systems out of which 4 were low pressure areas), 26 upper air cyclonic circulations and 4 troughs in the easterlies, 14 other troughs/wind discontinuities and one east west shear formed which affected the weather over the country during the month of February.

3.2.3. *Monthly rainfall*

The rainfall activity in the first week of the month over the country as a whole was very subdued. Thereafter under the influence of active western disturbances and their induced systems widespread rainfall/snowfall activity over Western Himalayan Region and isolated to scattered rainfall/thunderstorm activity over the adjoining plains was experienced over north and northwest India triggering landslides as well as avalanches. The easterly waves in the second week caused isolated to scattered rainfall/thunderstorm activity over the Peninsular region. The perturbations in the westerlies were stronger and occupied a wider latitudinal belt and their occasional interaction with easterlies, gave precipitation over parts of north, central and northeast India, during the remaining part of the month. The resultant hailstorms that occurred over parts of south peninsula, central and northern plains during the later part of February caused major damage to agriculture.

During the month, out of 36 meteorological sub-divisions, 9 sub-divisions received *large excess* rainfall (6 from Northwest India), 4 *excess*, 7 *normal*, 4 *deficient* and 10 *large deficient* rainfall (6 from South Peninsula). Two sub-divisions (Madhya Maharashtra and Konkan & Goa) did not receive any rain. Table 1 shows the sub-division wise rainfall statistics (mm) for February 2019.

TABLE 4

Some representative amounts of rainfall in cm for January and February 2019 (3 cm and above)

Date	Some representative amounts of rainfall in cm for January and February 2019 (3 cm and above)
1 Jan	Nil
2 Jan	Long Islands 11
3 Jan	Nil
4 Jan	Nil
5 Jan	Shalimar AGRO, Kupwara, Srinagar AGRO AWS and Pahalgam 4 each, Bandipora, Baramulla AWS, Srinagar IAF, Gulmarg, Srinagar, Gulmarg AWS, Harran AWS and Rambagh AWS 3 each
6 Jan	Batote 7, Nancowry 4, Udaipur 3
7 Jan	Hut Bay 10, Port Blair and Maya Bandar 7 each, Car Nicobar 5, Bhoranj 4, Long Islands 3
8 Jan	Long Islands 6, Maya Bandar 3
9 Jan	Nil
10 Jan	Nil
11 Jan	Nil
12 Jan	Nil
13 Jan	Dalhousie, Dalhousi Alha AWS, Manali and Seo Bagh 3 each
14 Jan	Nil
15 Jan	Nil
16 Jan	Car Nicobar 3
17 Jan	Nil
18 Jan	Nil
19 Jan	Hut Bay 3
20 Jan	Hut Bay 8, Car Nicobar 4
21 Jan	Banihal 6, Batote 5, Govindpura AWS 4, Quazigund 3
22 Jan	Udhampur IAF 12, Pathankot, Batote and Bharwain 9 each, Tibri, Gurudaspur, Govindpura AWS and Deoprayag 8 each, Kawa AWS, Nagina, Jallundur, Malakpur, Mukerian and Gautam Buddha Nagar 7 each, Baderwah, Ghamroor, Bijnor, Pauri, Adampur IAF and Banihal 6 each, Hoshiarpur AWS, Madhopur, Phangota, Ranjit Sagar Dam Site, Kathua, Ludhiana, Rajouri, Shahpur Kandi, Keertinagar, Nakodar, Rajhani AWS, Jakholi, Katra, Phagwara, Dharmasala, Car Nicobar, Long Islands, Samba AWS and Guler 5 each, Nuh, Sps Mayur Vihar, Halwara, Jammu City, Green Field Ps, Car Nicobar IAF, Baldwara, Sangraha, Ranikhet (G), Gairsain, Kasauli, Jammu IAF, Dalhousi Alha AWS, Kangra AP, Nagrota Surian, Dharchula, Samana, Guhla, Ukhimath and Gohar 4 each, Tehri Cwc, Tehri, Delhi UniversityObs, Harpur, Ghansali, Banjar, Meerath, Anandpur Sahib, Naina Davi, Mawana, Palampur, Bhoranj, Budhana, Thakurdwara, Banganaf, Saloni, Sarkaghat, Mehre (Barsar), Srinagar, Dharampur, Ghumarwin, Mukteswar, Chhansa, Banganar, Gulmarg AWS, Uttar Kashi Cwc, Quazigund, Kupwara, Nainital, Gulmarg, Batala, Nangal, Kheri, Nadaun, R L Bbmb, Baghpat, Uttar Kashi, Kukernag, Kandla Airport, Nawanshahr, Pithoragarh, Berthin AGRO, Aghar, Aya Nagar, Haldwani, Samba, Bhatwari, Hardwar, Ballabgarh, Jogindarnagar, Kahu, Bandipora, Baramulla AWS, Bahadurpur and Moradabad 3 each
23 Jan	Dalhousi Alha AWS 6, Bijnor, Dharmasala, Kheri, Mussoorie, Kotkhai, Mandi, Sangraha, Tiuni, Deoprayag and Shimla 5 each, Gohar, Nadaun, Nahan, Phangota, Naraingarh, Renuka / Dadhau, Keertinagar, Bharwain, Kalpa, Karnaprayag, Banjar, Solan, Munsyari, Kangra AP, Baderwah, Jakholi, Uttar Kashi CWC, Naina Davi, Hardwar, Shahpur Kandi and Nazibabad 4 each, Banihal, Uttar Kashi, Seo Bagh, Dehra Dun, Udhampur IAF, Gairsain, Laksar, Keylong, Palampur, Sarahan, Batote, Jagadhari, Hoshiarpur, Saloni, Bijahi, Ghamroor, Dunda, Bhuntar AP, Pauri, Manali, Bharmaur, Jogindarnagar, Jubbal, Kasauli, Theog, Chhatrari, Pathankot, Bajaura AGRO, Sunibhajji, Hoshiarpur AWS, Amb, Banganar, Guler, Rajgarh, Joshimath, Jollygrant, Rampur Bushar, Paonta, Sadhaura, Ropar, Aghar, N.Delhi (SFD), Una, Karsog, Banganaf, Tehri, Roorkee, Madhopur, Sarkaghat, Pandoh, Barkot, Tehri CWC, Talwandi Sabo, Tibri, Bharari, Mashobra AGRO, Sujanpur Tira, Mehre (Barsar) and Quazigund 3 each
24 Jan	Dharchula 3
25 Jan	Malanjkhand and Pendra 5 each, Amarkantak and Paraswad 4 each, Rupbas, Sapau, Seoni, Amarwara, Bichhia and Dhamangaon Rlwy 3 each

TABLE 4 (*Contd.*)

Date	Some representative amounts of rainfall in cm for January and February 2019 (3 cm and above)
26 Jan	Chandrapur and Kurkheda 7 each, Korchi and Munsyari 6 each, Dharmapuri, Bhiwapur, Desaiganj and Mana AP 5 each, Hathanoora, Mahasamund, Sindewahi and Faizabad 4 each, Kunda, Kalpi Tehsil, Lucknow AP, Bhatwari, Armori, Salekasa, Julapalle, Pauni, Uttar Kashi, Uttar Kashi Cwc, Machareddy, Ramnagar, Sundargarh, Nawabganj Tehsil, Sirauli Gauspur Tehsil, Tarabganj and Purola 3 each
27 Jan	Nangnoor (ARG) 10, Nanganur and Dubbak 9 each, Narmetta, Bhupalpalle and Mogullapalle 8 each, Huzurabad 7, Bijapur and Manthani 6 each, Bhopalpatnam, Thimmapur, Gangadhara, Bejjanki, Venkatapur, Jangaon, Parkal, Mustabad and Husnabad (ARG) 5 each, Sarangapur, Macherla and Sironcha 4 each, Karimnagar, Saroornagar, Bheemadevarpalle, Sultanabad, Julapalle, Sirsilla, Thimmajipeta, Tupran (ARG), Dharmasagar, Kondapak and Wankdi 3 each
28 Jan	Konijerla 8, Chandrugonda 6, Alampur, Dornakal, Thollada, Koyyalagudem, Nalgonda, Devarakonda, Nandigama and Suryapet 5 each, Madhira, Kusumanchi, Mahbubabad, Huzur Nagar, Garla, Bayyaram, Nidamanur, Atchampet, Kurnool, Chandur and Khammam 4 each, Julurpad, Marriguda, Kaveli, Virudhunagar, Vangoor, Macherla, Enkuru, Thimmajipeta, Peddaadiserlapalle, Chinthakam, Jadcherla, Kalyandrug, Nuzvid, Gudivada, Bonakal, Bhimadole, Tiruvuru, Kambadur and Yacharam 3 each
29 Jan	Denkanikottai 7, Arogyavaram 4, Marandahalli, Krishnagiri, Tadpatri, Penucondapuram, Madanapalle and Macherla 3 each
30 Jan	Nil
31 Jan	Bharwain 3
1 Feb	Tissa 7, Banihal 6, Batote, Baderwah and Dalhousi Alha AWS 5 each, Govindpura AWS 4, Dharmasala, Palampur, Kheri, Jogindarnagar, Udhampur IAF and Baijnath 3 each
2 Feb	Nil
3 Feb	Nil
4 Feb	Nil
5 Feb	Papanasam 3
6 Feb	Nil
7 Feb	Hoshiarpur AWS 8, Gulmarg AWS and Gulmarg 7 each, Srinagar IAF, Banihal, Govindpura AWS, Harran AWS, Naina Davi, Chamba AWS, Rambagh AWS, Hoshiarpur, Srinagar and Baderwah 5 each, Rajouri, Dharmasala, Kapurtala, Batote, Phagwara, Banganaf, Banganar, Nangal, Udhampur IAF, Gurudaspur, Adampur IAF, Shalimar AGRO, Katra, Awantipur IAF and Anantnag 4 each, Keylong, Malangpura AWS, Srinagar AGRO AWS, Dasuya, Palampur, Jammu City, Anantnag AWS, Samba, Jammu IAF, Quazigund, Kheri, Kawa AWS, Pahalgam AWS, Pahalgam, Samana, Ghamroor, Kupwara, Nadaun, Amb, Pathankot, Malakpur, Ranjit Sagar Dam Site, Kukernag, Baldwara, Samba AWS, Kangra AP, Kaiserganj and Baramulla AWS 3 each
8 Feb	Mukerian 14, Tibri and Dasuya 13 each, Naina Davi 12, Bharari, Kheri, Batote, Gurudaspur and Mehre (Barsar) 11 each, Barthin, Aghar, Dharmasala, Phangota and Nadaun 10 each, Hamirpur, Berthin AGRO, Bhoranj, Bharmaur, Kufri AWS, Banganar, Balachaur and Nangal 9 each, Kukernag, Sujanpur Tira, Ranjit Sagar Dam Site, Malakpur, Jogindarnagar, Deoprayag, Arki, Manali, Pauri, Ghumarwin, Kasauli, Baderwah, Banihal, Pathankot and Ghamroor 8 each, Paonta, Kathua, Dharampur, Hoshiarpur AWS, R L Bbmb, Madhopur, Rajhani AWS, Guler, Nagrota Surian, Sangraha, Khanna, Palampur, Chamba, Chamba AWS, Kangra AP, Shahpur Kandi, Renuka / Dadhau, Banjar, Minicoy, Pooh, Pachhad and Sundernagar 7 each, Dehra Gopipur, Amb, Adampur IAF, Quazigund, Sarkaghat, Seo Bagh, Chhatrari, Udhampur IAF, Kahu, Kotkhai, Kapurtala, Baijnath, Srinagar AGRO AWS, Shalimar AGRO, Una and Bharwain 6 each, Nabha, Bijahi, Baldwara, Keylong, Bhuntar AP, Anandpur Sahib, Anantnag, Jakholi, Keertinagar, Hoshiarpur, Anantnag AWS, Samana, Dalhousie, Dalhousi Alha AWS, Rajgarh, Banganaf, Bajaura AGRO, Shimla, Rampur Bushar, Muzaffarnagar, Barkot, Karsog, Mussoorie, Nawanshahr, Nahan and Khadrala 5 each, Sunibhajji, Shimla AP, Guhla, Gulmarg, Joshimath, Naraingarh, Awantipur IAF, Govindpura AWS, Dadupur, Rohru, Gulmarg AWS, Malangpura AWS, Pahalgam AWS, Chandigarh, Pithoragarh, Delhi UniversityObs, Delhi Ridge, Ukhimath, Kawa AWS, Pahalgam, Tehri, Uttar Kashi Cwc, Rajouri, Tajewala, Jagadhari, Ludhiana, Katra, Uttar Kashi, Ghansali and Saloni 4 each, Munsyari, Tiuni, Ropar, Pandoh, Haldwani, Srinagar, Mashobra AGRO, Narwana, Tehri Cwc, Bhatwari, Sarahan, Jammu City, Baghpat, N. Delhi (PLM), Jhandutta, Srinagar, Deoband, Kapkot, Rambagh AWS, Mukteswar, Rudraprayag, Kumarsain, Kalpa, Jammu IAF, Solan, Nainital, Karnaprayag, Bageshwar (Thmo), Faridabad, Fatehgarh Sahib, Phagwara, Sirhind, Samba AWS, Suar, Chhachhrauli, Halwara, Jollygrant, Batala, Garhshankar, Theog, Bahadurgarh and Patiala Rev 3 each
9 Feb	Bagaha 11, Satgaon and Haldwani 5 each, Bihpur and Nanpara 4 each, Dhengraghat, Maharajganj, Chanpatia, Rajauli, Baltara, Ramnagar, Gaunaha, Ranikhet (G), Haraiya and Chatra 3 each
10 Feb	Konni 12, Malur 9, Bengaluru CO 6, Nancowry and Bengaluru AP 5 each, Rayalpadu 4, Kodaikanal, Begur, Munnar KSEB and Sabour 3 each
11 Feb	Ajjampura 4, Kottayam, Hesaraghatta, Kuppady, Ambalavayal and Ottapalam 3 each
12 Feb	Nil
13 Feb	Kargil, Gulmarg, Gulmarg AWS and Asnawar 3 each
14 Feb	Nil

TABLE 4 (*Contd.*)

Date	Some representative amounts of rainfall in cm for January and February 2019 (3 cm and above)
15 Feb	Rajhani AWS 7, Kathua, Naraingarh, Gohar and Baldwara 6 each, Bharari, Khanna, Gurudaspur, Malakpur and Gautam Buddha Nagar 5 each, Jogindarnagar, Madhopur, Ghumarwin, Mehre (Barsar), Manali, Bhoranj, Pathankot, Kheri, Deoprayag, Tibri, Dharmasala, Shahpur Kandi and Sarkaghat 4 each, Nadaun, Aghar, Una, Joshimath, Ranjit Sagar Dam Site, Palampur, Berthin AGRO, Seo Bagh, Ranikhet (G), Kapurtala, Phangota, Mandi, Banganaf, Amritsar IAF, Naina Davi, Jakholi, Anandpur Sahib, Taran Taran, Banganar, Nagrota Surian, Udhampur IAF, Nangal, Hamirpur, Guler, Ukhimath, Baijnath, Ghamroor, Baderwah, Balachaur, Phagwara, Pahalgam AWS, Pahalgam, Kotkhai, Mawana, Keylong, R L Bbmb, Udaipura and Amb 3 each
16 Feb	Deoprayag, Dhampur and Nighasan 6 each, Keertinagar 5, Julapalle, Aryankavu, Purola, Jogindarnagar and Paraswad 4 each, Malanjkhand, Sivagiri, Bijnor, Pallari/Palari, Ayikudi, Khariar, Bahraich, Baderwah, Boden ARG, Rairangpur, Kuchinda, Panposh, Ambabhona, Mukteswar, Baloda Bazar, Mussoorie, Kheri, Bangiriposi, Paonta, Bramhapuri, Barkot, Sujanpur Tira and Lahunipara 3 each
17 Feb	Tuting 5, Gossaigaon 4, Namsai, Miao, Ernakulam South and Dhubri CWC 3 each
18 Feb	Lumding, Passighat, Tuting, Majbhat, Dholla Bazar, Tamulpur, Adirampattinam, Banjar and Hazuah 3 each
19 Feb	Sangraha 7, Gohar and Banjar 6 each, Kotkhai and Joshimath 5 each, Purola, Dharmasala, Khadrala, Anandpur Sahib and Mangan 4 each, Dharchula, Kufri AWS, Naharlagun, Solan, Mussoorie, Jogindarnagar, Shimla, Bijahi, Itanagar, Munsyari, Ghumarwin, Pachhad, Rajgarh, Bhatwari, Kheri, Rohru, Kumarsain, Baijnath, Renuka / Dadhau, Kangra AP, Rampur Bushar and Dalhousie 3 each
20 Feb	Coonoor 4
21 Feb	Batote and Jammu IAF 7 each, Katra, Udhampur IAF, Govindpura AWS and Banihal 6 each, Jammu City, Bhuntar AP, Amritsar IAF, Saloni and Baderwah 5 each, Kawa AWS, Rajouri, Banjar, Amritsar AWS, Gurudaspur, Kheri, Kathua, Malakpur, Samba and Deoprayag 4 each, Kufri AWS, Rajhani AWS, Batala, Kotkhai, Pathankot, Jogindarnagar, Keylong, Phangota, Madhopur, Manali, Gulmarg AWS, Samba AWS, Joshimath, Chamba AWS, Gulmarg, Rampur Bushar, Bajaura AGRO, Berthin AGRO, Munsyari, Sarahan, Shahpur Kandi, Chhatrari, Tibri and Pahalgam AWS 3 each
22 Feb	Batote, Bharwain and Saloni 7 each, Udhampur IAF 6, Bharmaur, Janjehli and Palampur 5 each, Baijnath, Banihal, Kargil, Govindpura AWS, Leh I.A.F., Aghar and Jogindarnagar 4 each, Leh AWS, Manali, Dharmasala, Munsyari, Chamba AWS, Quazigund, Bhoranj, Kupwara, Bhuntar AP, Jubbal, Joshimath, Bharari, Baderwah and Baramulla AWS 3 each
23 Feb	Nil
24 Feb	Panbari 3
25 Feb	Ghatsila 9, Rairangpur 7, Barrackpur IAF 6, Keiri AWS, Uluberia and Kolkata AP 5 each, Kuchinda 4, Bashirhat, Kolabira ARG, Jhumpura, Lahunipara, Jamshedpur AP, Lakhanpur ARG, Tiring, Champua, Joda ARG, Kalaikunda and Harinkhola 3 each
26 Feb	Burdwan and Kaptipada ARG 5 each, Tuting and Digha 4 each, Harichandanpur ARG, Ghatagaon, Kailashahar, Arundhutinagar, Karanjia, Amraghat, Lengpui, Durgapur, Udala, Agartala AP, Aizawal, Narsinghpur, Harinkhola and Telkoi 3 each
27 Feb	Safipur 12, Durgachak 11, D. P. Ghat 8, Bhograi, Jaleswar and Bagati (Magra) 7 each, Barrackpur IAF 6, Kolkata, Baripada, Kalyani Smo, Digha, Tuting and Kaniha ARG 5 each, Joda ARG, Kolkata AP, Guhla, Basudevpur AWS, Korei ARG, Chandanpur, Balimundali, Diamond Harbour and Deoprayag 4 each, Udala, Misrikh, Midnapore, Midnapore Cwc, Samakhunta AWS, Balachaur, Champua, Nh5 Gobindpur, Bangiriposi, Mohanpur, Keertinagar, Canning Town, Harinkhola, Uluberia, Sukinda, Passighat, Pehowa, Patiala, Contai, Tezu, Kaptipada ARG and Pechiparai 3 each
28 Feb	Diamond Harbour and Canning Town 13 each, Kolkata AP and Kalaikunda 9 each, Durgachak 8, Bashirhat, Kolkata and Uluberia 7 each, Barmul and Banki ARG 6 each, Mohanpur, Midnapore, Midnapore CWC, Tikabali, Bijnor and Munsyari 5 each, Athgarh, Bagaha, Haldwani, Lunglei and Kotagarh 4 each, Vijaywada AP, Agartala AP, Narsinghpur, Malda, Dumka, Tamenglongi, Hindol, Sriniketan, Cherrapunji, Cherrapunji (RKM), Williamnagar, Hasanpur, Harichandanpur ARG, Cuttack, D. P.Ghat, Ghatagaon, Gohar, Jhandutta, Balasore and Pakuria 3 each

3.2.4. *Temperature*

The maximum temperatures in the east and northeast India in the first half of the month were mostly *above normal* to *markedly above normal*. They were generally *below normal* to *appreciably below normal* over North and Northwest India and normal over Central and Peninsula India. There was a rise in maximum temperatures in the third week, over southern parts of central India and Peninsula India, while drop in temperatures over East and Northeast India in correspondence with the precipitation over the region. In the last few days at the end of the month, there was a drop in temperatures over the country outside the south Peninsula.

The minimum temperatures were mostly *normal* over south Peninsular region, *normal* or *below normal*

over East and Northeast India except towards the month's end. A drop in temperature over northwest and central India was observed in coincidence with precipitation/ hailstorms. The lowest minimum temperature recorded during the month over the plains was 1.4 °C at Churu (West Rajasthan) on 9th February.

As there was less gap between successive western disturbances and sustained northerly winds, long cold spells were not observed in this month. *Severe cold wave* conditions prevailed on 1 day each in some parts of Vidarbha and at isolated places in Odisha. *Cold wave* conditions were observed on 1 to 3 days in some parts of Odisha, Madhya Pradesh, Madhya Maharashtra, Marathwada, Gujarat, Chattisgarh and Gangetic West Bengal. *Cold day conditions* prevailed on 1 or 2 days each in Haryana, Punjab, Jammu and Kashmir, West Rajasthan and Gujarat state, Madhya Maharashtra, Vidarbha and Bihar. *Cold day conditions* were observed over Northwest India and more intense conditions over Central India during the first fortnight of the month.

3.2.5. *Damages associated with disastrous weather events and damage*

According to media reports at least 15 people were killed in snow avalanches across Jammu and Kashmir including seven in a massive one that buried a police post near Jawahar Tunnel in south Kashmir's Anantnag district on 7th and 8th. Two men were crushed by boulders during landslides at two different spots on the highway in Ramban district in Jammu and Kashmir. Hit by an avalanche, six soldiers were killed in the Shipkila sector of Himachal Pradesh on 20th. Heavy rains and hailstorms caused significant damage to crops in large parts of Haryana, Punjab and western Uttar Pradesh.

Appendix

Definitions of the terms given in '*Italics*'

(A) Rainfall

(*i*) *Percentage departure from normal*

Large excess	-	+ 60% or more
Excess	-	+20% to +59%
Normal	-	-19% to +19%
Deficient	-	-20% to -59%
Large deficient	-	-60% to -99%
No Rain	-	-100%

(*ii*) *Intensity* (*during the past 24 hours period ending at 0300 UTC*)

Heavy rainfall	-	6.5-11.5 cm
Very heavy rainfall	-	11.6-20.4 cm
Extremely heavy rainfall	-	20.5 cm or more
Heavy snowfall	-	64.5 cm to 115.5 cm

(B) Temperatures

Cold Wave

Cold wave is declared when minimum temperature is 10 °C or less for stations over the plains and 0 °C or less for hilly regions

(a) *Based on Departure*

Cold Wave	-	Negative Departure from normal is 4.5 °C to 6.4 °C
Severe Cold Wave	-	Negative Departure from normal is more than 6.4 °C

(b) *Based on Actual Minimum Temperature* (*For plain stations only*)

Cold Wave	-	When minimum temperature is ≤ 04 °C
Severe Cold Wave	-	When minimum temperature is ≤ 02 °C

(c) *Cold Day*

It is considered when minimum temperature is 10 °C or less for plains and 0 °C or less for Hilly regions

Cold day	-	Maximum Temperature Departure is -4.5 °C to -6.4 °C
Severe Cold day	-	Maximum Temperature Departure is < -6.4 °C

Markedly below normal	-	Departure of minimum temperature from normal is from -5 °C or less
Appreciably below normal	-	Departure of minimum temperature from normal is from -3.1 °C to -5 °C
Below normal	-	Departure from normal is -1.6 °C to -3.0 °C
Normal	-	Departure from normal is -1.5 °C to +1.5 °C
Above normal	-	Departure of minimum temperature from normal is +1.6 °C to +3.0° C
Appreciably above normal	-	Departure of minimum temperature from normal is from +3.1 °C to +5 °C
Markedly above normal	-	Departure of minimum temperature from normal is + 5 °C or more
(C) Fog		
Dense Fog	-	When the visibility is between 50-200 m
Very Dense Fog	-	When the visibility is less than 50 m