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Weather in India

POST MONSOON SEASON (October-December 2016)†

1. Introduction

The post monsoon season, also known as the cyclone season, witnessed the formation of five intense low pressure systemsthis year. One Very Severe Cyclonic Storm (VSCS) 'VARDAH' formed over South east Bay of Bengal in the month of December and two Cyclonic Storms (CS) 'KYANT' & 'NADA' formed over the Bay of Bengal in October and November respectively. Two Depressions (D) formed during the month of November and December.

Of these, the CS 'Kyant' (21-27 Oct) and CS 'Nada' (29 Nov-2 Dec) formed over Bay of Bengal weakened *in-situ* over the Sea area with the intrusion of continental dry air into the system from the west. The Depression (2-6 Nov) formed over southeast Bay of Bengal, too dissipated near the coast due to high vertical wind shear and intrusion of dry air. The CS 'Nada' crossed Tamil Nadu coast near Nagapattinam after weakening into a depression.The VSCS 'Vardah' (6-13 Dec) crossed the north Tamil Nadu coast close to Chennai with a severe intensity. It caused copious rainfall over the large rainfall *deficient* regions. The remnant of the CS 'Vardah' from the Bay of Bengal crossed peninsular India and concentrated into a Depression (17-18 Dec) over the Southwest Arabian Sea. It moved west-southwestwards and weakened *in-situ* subsequently.

The VSCS 'Vardah' created havoc over Chennai and adjoining districts claiming 18 human lives. In its formative stage, it caused heavy to very heavy rainfall over Andaman & Nicobar Islands that left about 2400 tourists stranded in Havelock Island.

There had been 26 such instances in the recorded history (1891-2016) when, Cyclonic Storms of severe intensity crossed either the north or south Tamil Nadu coast during Post Monsoon Season.

Tracks of these systems are given in Fig. 2. Further details are available in the article on 'Cyclones & Depressions over the north Indian Ocean 2016' published in the July 2017 issue of Mausam.

Southwest monsoon withdrew from the entire country on 28th October. The northeast monsoon (NEM) rains commenced over south Peninsular India from 30th October and ceased on 4th January 2017.

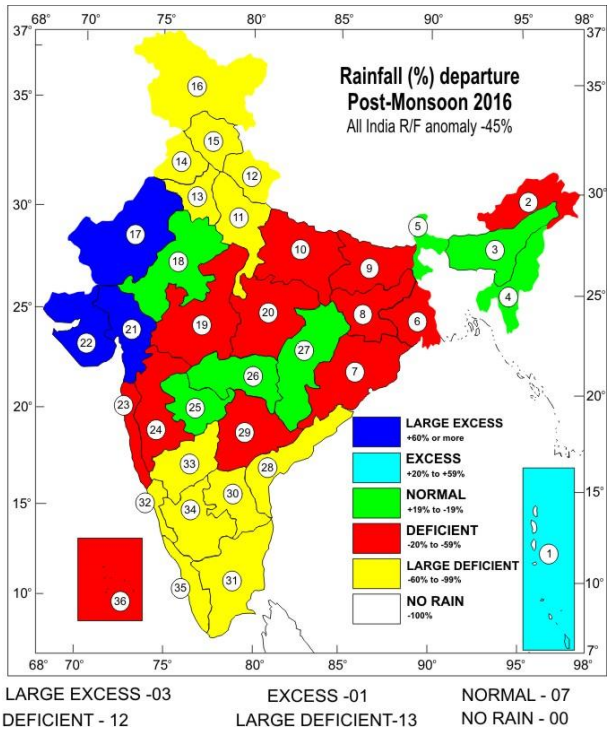

Fig. 1. Sub-divisionwise seasonal rainfall departure from normal (%) for Post monsoon season (October to December 2016). Sub-divisions are indicated by number on the map & bold letters in legend. The rainfall anomaly values for these 36 sub-divisions are indicated below :

1	44	**7**	-28	**13**	-79	**19**	-24	**25**	-01	**31**	-62
2	-30	**8**	-50	**14**	-92	**20**	-50	**26**	-08	**32**	-63
3	-07	**9**	-22	**15**	-93	**21**	94	**27**	02	**33**	-77
4	-15	**10**	-57	**16**	-93	**22**	119	**28**	-67	**34**	-70
5	-16	**11**	-82	**17**	91	**23**	-27	**29**	-40	**35**	-62
6	-44	**12**	-82	**18**	18	**24**	-40	**30**	-66	**36**	-50

The maximum temperatures were above normal and minimum temperatures were near normal for most parts of the country during the season.

*Cold wave conditions** prevailed over northern and central parts of India during the second half of November and December. Dense fog affected normal life in North, North east, east Rajasthan and Saurashtra and Kutch parts of India especially in the month of December and latter part of November.

* *Definitions of terms in italics (other than subtitles) are given in Appendix.*

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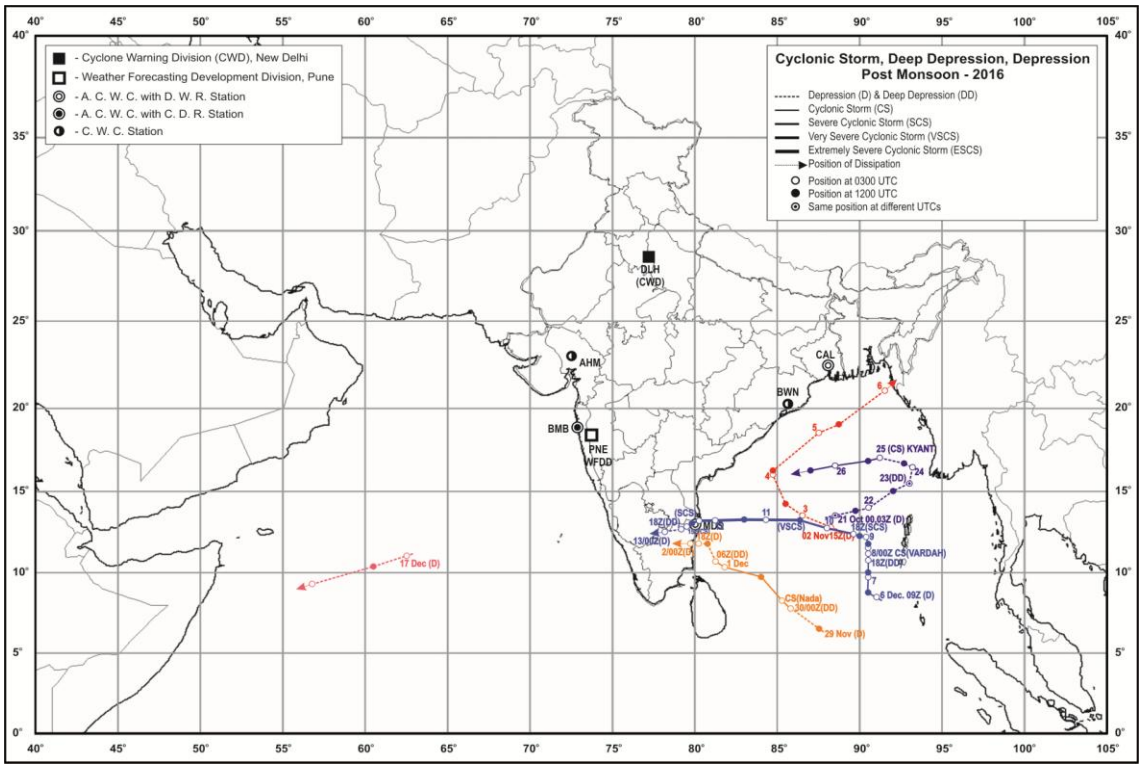

Fig. 2. Cyclones and depressions during post-monsoon season 2016

Major weather related disasters that occurred over the country during this period apart from cold wave and fog were related to the active monsoon conditions during the withdrawal phase. It led to floods in Marathwada & Assam.

2. Seasonal rainfall (October-December)

The meteorological sub-division wise rainfall percentage departures from normal are given in Fig. 1 and Table 1.

Rainfall over the country as a whole during the season was *below normal* and substantially *below normal* over the core region of NEM. Except for a few subdivisions of north, east, central and adjoining Peninsular India and the Andaman & Nicobar Islands which received *large excess/ excess/ normal* rainfall, remaining parts of the country received *deficient/ large deficient* rainfall. It was subdued during October and November and *near normal* during December.

3. Monthly features

3.1. *October*

3.1.1. *Withdrawal of southwest monsoon*

The southwest monsoon (SWM) withdrew from the entire country on 28th October, nearly 13 days later than the normal date of 15th October. The withdrawal of SW Monsoon was halted owing to the temporary enhancement of southwesterlies over the southernmost parts of the Indian Seas during the genesis phase of the Cyclonic Storm 'KYANT'. An account of the withdrawal of southwest Monsoon 2016 is provided in the seasonal summary of SWM published in the last issue of Mausam.

3.1.2. *Commencement of northeast monsoon rains*

The Inter Tropical Convergence Zone (ITCZ) remained north of its normal position in October owing to active cyclogenesis conditions over Indian Sea, thus delaying the commencement of NEM. The establishment of north-easterlies over the east coast upto 850 hPa level led to commencement of NEM over coastal regions of southeast peninsula on 30th October, ten days later than the normal date of 20th October.

3.1.3. *Storms and depressions*

The first intense low pressure system of this NEM season formed as CS 'KYANT' (21-27 October) over the east central Bay of Bengal. Initially it moved in east-northeast direction as a D and then northwards after intensifying into a DD. Then re-curving and moving west-northwestwards under the influence of an anti-cyclone in mid and upper tropospheric levels, it intensified into a

TABLE 1

Sub-divisionwise rainfall (mm) for each month and season as a whole (October-December, 2016)

S. No.	Meteorological Sub-divisions	October			November			December			Season		
		Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)
1.	A. & N. Islands	287.2	296.7	-3	181.7	253.7	-28	533.7	145.5	267	1002.6	695.9	44
2.	Arunachal Pradesh	172.7	183.0	-6	8.4	45.8	-82	4.6	38.4	-88	185.7	267.2	-30
3.	Assam & Meghalaya	136.5	154.8	-12	38.2	28.4	34	7.4	11.8	-37	182.1	195.0	-7
4.	Naga., Mani., Mizo. and Tri.	114.7	179.8	-36	90.3	50.7	78	1.7	12.5	-86	206.7	243.0	-15
5.	Sub-Himalayan West Bengal & Sikkim	155.6	154.2	1	0.0	20.3	-99	0.3	10.8	-98	155.8	185.3	-16
6.	Gangetic West Bengal	69.8	129.3	-46	19.2	23.3	-18	0.0	7.5	-100	89.0	160.1	-44
7.	Orissa	93.5	111.6	-16	10.4	27.7	-62	0.5	4.8	-90	104.4	144.1	-28
8.	Jharkhand	45.6	75.2	-39	0.0	9.9	-100	0.0	6.5	-100	45.6	91.6	-50
9.	Bihar	60.8	64.8	-6	0.0	6.9	-100	0.0	5.8	-100	60.8	77.5	-22
10.	East Uttar Pradesh	25.9	49.2	-47	0.0	4.5	-100	0.0	6.7	-100	25.9	60.4	-57
11.	West Uttar Pradesh	9.6	42.1	-77	0.0	4.7	-100	0.0	7.6	-100	9.6	54.4	-82
12.	Uttarakhand	12.7	58.6	-78	0.0	9.7	-100	3.5	21.3	-84	16.2	89.6	-82
13.	Haryana, Chandigarh & Delhi	5.2	17.6	-71	0.0	4.9	-99	1.0	6.9	-86	6.2	29.4	-79
14.	Punjab	1.9	22.0	-92	0.5	5.7	-91	1.1	13.3	-92	3.4	41.0	-92
15.	Himachal Pradesh	5.3	42.5	-88	0.0	20.3	-100	2.2	45.4	-95	7.5	108.2	-93
16.	Jammu & Kashmir	3.3	38.9	-92	0.0	33.0	-99	6.1	59.9	-90	9.4	131.8	-93
17.	West Rajasthan	18.1	5.4	235	0.0	2.5	-100	0.0	1.6	-100	18.1	9.5	91
18.	East Rajasthan	32.6	16.9	93	0.0	7.4	-99	0.0	3.3	-100	32.6	27.6	18
19.	West Madhya Pradesh	40.6	34.4	18	0.0	11.0	-100	0.0	7.7	-100	40.6	53.1	-24
20.	East Madhya Pradesh	29.0	37.5	-23	0.0	9.9	-100	0.0	10.4	-100	29.0	57.8	-50
21.	Gujarat Region	66.9	23.4	186	0.0	9.4	-99	0.0	1.7	-100	66.9	34.5	94
22.	Saurashtra & Kutch	64.7	18.1	257	0.0	10.7	-100	0.0	0.7	-100	64.7	29.5	119
23.	Konkan & Goa	106.3	120.8	-12	2.0	22.7	-91	0.1	5.6	-98	108.5	149.1	-27
24.	Madhya Maharashtra	62.4	79.0	-21	1.1	22.7	-95	0.9	6.1	-85	64.4	107.8	-40
25.	Marathawada	100.8	72.3	39	0.0	21.2	-100	0.2	8.1	-98	100.9	101.6	-1
26.	Vidarbha	75.0	59.6	26	0.0	13.2	-100	0.0	9.0	-100	75.0	81.8	-8
27.	Chhattisgarh	79.8	63.3	26	0.0	9.2	-100	0.0	5.5	-100	79.8	78.0	2
28.	Coastal Andhra Pradesh	59.7	193.2	-69	13.1	106.6	-88	36.9	27.6	34	109.7	327.4	-67
29.	Telangana	70.4	92.2	-24	0.5	21.6	-98	0.4	5.5	-92	71.3	119.3	-40
30.	Rayalaseema	14.1	129.4	-89	5.4	66.1	-92	54.4	23.7	130	73.9	219.2	-66
31.	Tamil Nadu	65.8	180.2	-63	33.8	170.0	-80	66.5	88.0	-24	166.0	438.2	-62
32.	Coastal Karnataka	77.4	189.5	-59	14.4	59.6	-76	5.7	13.7	-58	97.5	262.8	-63
33.	North Interior Karnataka	28.7	112.0	-74	3.1	27.3	-88	1.0	6.0	-83	32.8	145.3	-77
34.	South Interior Karnataka	21.9	147.7	-85	9.1	49.2	-82	31.0	12.7	144	61.9	209.6	-70
35.	Kerala	105.1	292.3	-64	57.9	150.9	-62	22.0	37.5	-41	185.0	480.7	-62
36.	Lakshadweep	58.6	157.1	-63	32.0	117.7	-73	74.7	58.8	27	165.4	333.6	-50

TABLE 2

Details of the weather systems during October 2016

S. No.	System	Duration	Place of first Location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**) *Cyclonic storm*						
1.	Cyclonic storm (Kyant)	21-27	East central and adjoining southeast Bay of Bengal centered near Lat. 13.5° N/ Long. 88.5° E	Northeast-west-west-southwest	West central Bay of Bengal centered near Lat.15.3° N/ Long. 83.0° E, 220 kms east-southeast of Machilipatnam	Became well marked low pressure area over west central Bay of Bengal off Andhra Pradesh coast on 28. Details are given in the article on Storms & Depressions over the north Indian Ocean-2016
(**B**) *Western Disturbances /Eastward moving systems*						
(*i*) *Upper air cyclonic circulation*						
1.	Upto Upper tropospheric levels	2-9	Southwest Iran and adjoining Persian Gulf	Northeast	Northern parts of Jammu & Kashmir and neighbourhood	Moved away northeastwards in the evening of 9. A trough lay aloft during 2, 3 and 5
2.	Between 3.1 & 3.6 kms a.s.l.	18-20	North Pakistan and neighbourhood	Do	Eastern parts of Jammu & Kashmir and neighbourhood	Moved away east-northeastwards on 21
3.	Between 3.1 & 4.5 kms a.s.l.	20-22	Do	Do	Northern parts of Jammu & Kashmir and neighbourhood	Moved away east-northeastwards on 23
4.	Upto Mid tropospheric levels	29 Oct - 1 Nov	Do	Do	Eastern parts of Jammu & Kashmir and neighbourhood	It lay as a trough extended along Long. 72° E to the north of Lat. 32° N (axis at 5.8 kms a.s.l.) on 31 Oct. Moved away east-northeastwards on 1 November evening
(*ii*) *As a trough*						
1.	Mid & upper tropospheric levels	8-11	Along Long. 62° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Northeast	Along Long. 78° E to the north of Lat. 28° N (axis at 5.8 kms a.s.l.)	Moved away northeastwards on 12
2.	Do	12-14	Along Long. 65° E to the north of Lat. 28° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 76° E to the north of Lat. 32° N (axis at 5.8 kms a.s.l.)	Moved away east-northeastwards on 15
3.	Mid tropospheric level	23-25	Along Long. 64° E to the north of Lat. 32° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 76° E to the north of Lat. 34° N (axis at 5.8 kms a.s.l.)	Moved away east-north eastwards on 26
(**C**) *Other upper air cyclonic circulations*						
1.	Upto Mid tropospheric levels	3-5	West central Bay of Bengal off north Andhra Pradesh coast	Stationary	*In-situ*	It merged with the cyclonic circulation over northwest Bay of Bengal on 6
2.	Upto Mid tropospheric levels	3-10	Northeast Bay of Bengal and neighbourhood	Northwest	Odisha and adjoining Jharkhand	Became less marked on 11
3.	Do	8-11	East central Arabian Sea off Konkan coast	South	Coastal Karnataka and neighbourhood	Became less marked on 12
4.	Do	10-12	Northwest Bay of Bengal and adjoining coastal areas of West Bengal and north Odisha	North	Southwest Bay of Bengal and neighbourhood	It merged with the cyclonic circulation over Meghalaya and neighbourhood on 13

TABLE 2 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
5.	Upto Mid tropospheric levels	11-14	West Assam and neighbourhood	East	Meghalaya and neighbourhood	Became less marked on 15
6.	Between Lower & mid tropospheric levels	14-16	Kerala and adjoining Lakshadweep area	West	Lakshadweep area and neighbourhood	Became less marked on 17
7.	Upto Lower tropospheric levels	15-17	Southeast Bangladesh and neighbourhood	East	Tripura and neighbourhood	Became less marked on 18
8.	Upto Mid tropospheric levels	15-17	Southwest Bay of Bengal off Tamil Nadu coast	Stationary	*In-situ*	It merged with the trough in the lower levels extending from east central Bay of Bengal to southwest Bay of Bengal on 18
9.	Upto Lower tropospheric levels	17	Southwest Bay of Bengal off Sri Lanka coast	Do	Do	Became less marked on 18
10.	Between 2.1 & 3.6 kms a.s.l.	18	Gangetic West Bengal and neighbourhood	Do	Do	Became less marked on 19
11.	Between Lower & mid tropospheric levels	22-24	Southeast Arabian Sea and adjoining Lakshadweep area	West	Southeast Arabian Sea and neighbourhood	Became less marked on 25
12.	Do	24-25	Mizoram and neighbourhood	North	Bangladesh and adjoining Meghalaya	Became less marked on 26
13.	Upto Mid tropospheric levels	27	Gulf of Siam and neighbourhood	Stationary	*In-situ*	Became less marked on 28
14.	At lower levels	28	East Assam and neighbourhood	Do	Do	Became less marked on 29
15.	Between Lower & mid tropospheric levels	28-31	East central Bay of Bengal and neighbourhood	North	North Bay of Bengal and neighbourhood	Became less marked on 1 November
16.	Upto Lower tropospheric levels	31 Oct - 1 Nov	Interior Tamil Nadu and adjoining Kerala and south Karnataka	West	Southeast Arabian Sea off Kerala coast	Became less marked on 2 November. Initially it lay embedded in the shear zone during 28-30
(**D**)	*Trough in easterlies*					
1.	At lower levels	18-20	From the cyclonic circulation over east central Bay of Bengal and neighbourhood to southwest Bay of Bengal	Stationary	*In-situ*	Became less marked on 21
2.	Do	27	From the depression over west central Bay of Bengal to Bangladesh across northwest Bay of Bengal	Do	Do	Became less marked on 28
3.	At mean sea level	30	Southwest Bay of Bengal off Tamil Nadu coast	Do	Do	Became less marked on 31
(**E**)	*Other troughs/Wind discontinuity*					
1.	Between 3.6 & 4.5 kms a.s.l.	12-13	East Bihar to north Bay of Bengal across Gangetic West Bengal	West	Sub- Himalayan West Bengal & Sikkim to north Bay of Bengal across Bangladesh	Became less marked on 14

TABLE 2 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(F)	*East-west shear zone*					
1.	Between 1.5 & 3.6 kms a.s.l.	13	Along Lat. 10° N	Stationary	*In-situ*	Became less marked on 14
2.	At mid tropospheric levels	19-20	Along Lat. 10° N	North	Along Lat. 11° N	Became less marked on 21
3.	Between 4.5 & 5.8 kms a.s.l.	24	Along Lat. 11° N	Stationary	*In-situ*	Became less marked on 25
4.	At lower levels	28 – 29	From the low pressure area over west central Bay of Bengal off Andhra Pradesh coast to Karnataka across Rayalaseema and south interior Karnataka	Do	Do	Became less marked on 30.

CS (KYANT). Thereafter, with the intrusion of continental dry air in to the system, it weakened *in-situ* over west central Bay of Bengal off Andhra coast. It did not cause any adverse weather over the mainland but prolonged the further withdrawal of SW monsoon.

3.1.4. *Other synoptic features and associated weather*

Table 2 gives a summary of the synoptic features for the month of October, 2016. The sub-divisionwise percentage departures of rainfall from normal & significant amounts of rainfall are given in Table 1 & 5 respectively.

The presence of east west shear zone and embedded cyclonic circulations caused *active to vigorous* monsoon conditions over central and Peninsular India. It caused *scattered to isolated* rainfall with heavy rain at *isolated* places over central India and *widespread to fairly wide spread* rainfall with *heavy to very heavy* rainfall at *isolated* places over north Peninsular India during the first week. The southward shift of sub-tropical westerly Jet stream and associated changes in the lower troposphreic levels such as establishment of an anti cyclone, deduction in moisture and dry weather over the region led to withdrawal of SW monsoon from some parts of the northwest India.

As second week progressed, the mid-latitude circulations dominated the northern half of India thereby reducing the rainfall activity over the northern parts of the country. This led further withdrawal of SWM from most parts of northwest India and some parts of western and central India. Development of fresh cyclonic circulation over northern parts of Bay of Bengal caused *active to vigorous* monsoon conditions over eastern and north eastern parts and northern parts of Peninsular India. It caused *widespread to fairly widespread* rainfall with *heavy to very heavy rainfall* at a *few* places and *extremely heavy rainfall* at *isolated* places over these regions during the second week.

The second half of October saw rapid withdrawal of SWM from major parts of India initially; however with the formation of a low pressure area over the Bay of Bengal and its further rapid intensification into CS 'Kyant' enhanced the southwesterlies over the south Peninsular India, thereby halting the further withdrawal of SWM from southern most parts of India.

With the weakening of the CS 'Kyant' over the Sea further withdrawal of SWM from the entire country took place on 28th October, 2016. The establishment of north-easterlies at 850 hPa over the east coast of India led to commencement of NEM over south Peninsular India on 30th October, 2016.

SWM was *vigorous* on 5 days over Gujarat Region and on 1 to 3 days over Arunachal Pradesh, Assam and Meghalaya, West Bengal & Sikkim, Odisha, Bihar, east Rajasthan, west Madhya Pradesh, Saurashtra & Kutch, Maharashtra state, Chhattisgarh, Telangana and coastal Karnataka. It was active on 1 to 3 days over Arunachal Pradesh, Assam & Meghalaya, Nagaland- Manipur-Mizoram-Tripura, Sub-Himalayan West Bengal & Sikkim, Odisha, east UttarPradesh, Maharashtra state, Chhattisgarh, coastal Andhra Pradeshand Telangana, coastal & south interior Karnataka and Kerala.

3.1.5. *Temperature*

Rainfall activity over north Peninsular India during the first half of October kept the maximum temperatures *below normal* over western parts of the country and

TABLE 3

Details of the weather systems during November 2016

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 (Nada)	29 Nov (1200 UTC) - 2 Dec (0000 UTC)	Southeast Bay of Bengal centred near Lat. 6.5° N/ Long. 87.5° E	West-northwest	North Tamil Nadu centred near Lat. 10.8° N / Long. 79.7° E	It weakened into well marked low pressure area and low pressure area over interior Tamil Nadu on 2. Details are given in the article on Storms & Depressions over the north Indian Ocean-2017
(**B**)	*Deep Depression/Depression*					
1.	Depression	2-6	Southeast Bay of Bengal and neighbourhood centered near Lat. 12.8° N/ Long. 88.2° E	Northwest-north and then northeast	Northeast Bay of Bengal centered near Lat. 21.0° N/ Long. 91.5° E	Details are given in the article on Storms & Depressions over the north Indian Ocean-2017
(**C**)	*Western disturbances /eastward moving systems*					
(*i*)	*Upper air cyclonic circulation*					
1.	Upto mid tropospheric levels	7-14	Western parts of Iran and neighbourhood	East northeast	Eastern parts of Jammu & Kashmir and neighbourhood	Moved away east northeastwards on 14 evening. It lay as a trough with its axis at 5.8 kms a.s.l. during 8-10 and as a trough aloft during 11-14
2.	Do	14	North Afghanistan and neighbourhood	Stationary	*In-situ*	Moved away east northeastwards on 15
3.	Do	22-24	Do	Northeast	Eastern parts of Jammu & Kashmir and neighbourhood	Moved away northeastwards on 25
4.	Between 2.1 & 4.5 kms a.s.l. levels	25-27	North Pakistan and neighbourhood	Do	Do	Moved away northeastwards on 28
5.	Between 3.1 & 4.5 kms a.s.l. levels	29-30	North Pakistan and adjoining Jammu & Kashmir	East-northeast	Eastern parts of Jammu & Kashmir	It moved away east-northeastwards on 1 December
(*ii*)	*Trough in westerlies*					
1.	Mid tropospheric levels	3-5	Along Long. 57° E to the north of Lat. 32° N (axis at 5.8 kms a.s.l.)	Northeast	Along Long. 82° E to the north of Lat. 33° N (axis at 5.8 kms a.s.l.)	Moved away northeastwards on 6. Initially it lay as a cyclonic circulation extending upto 3.1 kms a.s.l. over Iran and neighbourhood on 1 & 2
2.	Do	2-8	Along Long. 82° E to the north of Lat. 22° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 80° E to the north of Lat. 35° N (axis at 5.8 kms a.s.l.)	Became less marked on 9
3.	Do	6-8	Along Long. 73° E to the north of Lat. 35° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 80° E to the north of Lat. 35° N (axis at 9.6 kms a.s.l.)	Moved away eastwards on 8 evening
4.	Do	25-26	Along Long. 55° E to the north of Lat. 32° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 62° E to the north of Lat. 35° N (axis at 5.8 kms a.s.l.)	Initially it lay as an upper air cyclonic circulation extending upto mid tropospheric levels over northern parts of Iran and neighbourhood on 23 & 24. Moved away northeastwards on 27
5.	Do	28 Nov - 1 Dec	Along Long. 50° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 70° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Moved away northeastward on 2 December

TABLE 3 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(*iii*)	*As an Induced cyclonic circulation*					
1.	Upto mid tropospheric levels	11-13	Central Pakistan and neighbourhood	East	North Rajasthan and neighbourhood	Became less marked on 14
(**D**)	*Other upper air cyclonic circulations*					
1.	Between 3.1 & 3.6 kms a.s.l.	1-3	North Chhattisgarh and neighbourhood	Southwest	Vidarbha and neighbourhood	Became less marked on 4
2.	Upto mid tropospheric levels	4-9	Malaya Peninsula and neighbourhood	Northwest	Northern parts of Malacca	Became less marked on 10
3.	Do	7-13	Northeast Bangladesh and adjoining south Assam and Tripura	Quasi-stationary	East Assam and neighbourhood	It was associated with the Depression formed over Bay of Bengal during 2 -6. It lay as a trough extended from west Arunachal Pradesh to Bangladesh on 13 and became less marked on 14
4.	At lower levels	7	Comorin area and neighbourhood	Stationary	*In-situ*	Became less marked on 8
5.	Upto mid tropospheric levels	9-10	Lakshadweep and neighbourhood	South	Lakshadweep and adjoining Maldives areas	Became less marked on 11
6.	Do	11-13	Coastal and adjoining interior Karnataka	West	East central Arabian Sea and adjoining coastal Karnataka	It merged with the trough in easterlies extended from southeast Sri Lanka to south Konkan across Comorin area to Kerala coast on 14
7.	Upto lower tropospheric levels	16-18	North Bangladesh and neighbourhood	Southeast	Mizoram and neighbourhood	Became un-important on 19
8.	Upto mid tropospheric levels	21-29	South Assam and neighbourhood	Do	Do	Became less marked on 30
(**E**)	*Trough in easterlies*					
1.	At mean sea level	13-20	From southwest Bay of Bengal off Sri Lanka to north Tamil Nadu coast	West	Southeast Arabian sea and adjoining Lakshadweep - Maldives areas	Initially it lay as a cyclonic circulation extending upto 3.1 kms a.s.l. during 8 -11 and as a trough extending upto lower tropospheric levels on 12. A cyclonic circulation extending upto 0.9 km a.s.l. lay embedded from 14-15 and became less marked on 16. The trough became un-important on 21
2.	Do	13	From Lakshadweep area to south Konkan coast	Stationary	*In-situ*	It merged with the trough from southeast Sri Lanka to south Konkan on 14
3.	Do	14-21	South Andaman Sea and neighbourhood	West	Equatorial Indian ocean to southwest Bay of Bengal off Sri Lanka coast	Became less marked on 22
4.	Do	21-28	Comorin area to south Konkan coast	Do	Southeast Arabian Sea and neighbourhood	Became un-important on 29
5.	Do	20-26	Malay peninsula and neighbourhood	Do	Southwest Bay of Bengal and neighbourhood	Became un-important on 27

subdued rainfall over other led to *normal to above normal* temperatures over the rest of the country. Minimum temperature was *below normal* over Central and adjoining part of Peninsular India and eastern parts of the country and *normal to above normal* elsewhere.

No *heat wave/ cold wave* condition occurred during the month.

The month's highest maximum temperature was 40.5 °C recorded at Jaisalmer (west Rajasthan) on 8th October, 2016 and the lowest minimum temperature was 10.6 °C recorded at Jeur (Madhya Maharashtra) on 21st October, 2016 in the plains of the country.

3.1.6. *Disastrous weather events and associated damage*

As per press report, incessant heavy rain over four districts of Marathwada led to flash floods in many parts of the region. It claimed 5 human lives and some livestock's. Standing crops over an area of 15 lakh hectares were damaged. Flash flood were also reported from Medak district in Telangana with one casualty where all major reservoirs of Godavari and Krishna basin flooded due to heavy rainfall in catchment area. Heavy rain caused Brahmaputra and its tributaries overflowing leading to inundation of low lying areas of Barpetra and Lakhimpur districts. Around 50,000 people were affected and 1000 hectares of crops damaged in the floods. Thunderstorm/ lightning related incidents claimed 7 lives in Rajasthan, 6 in Maharashtra and 2 in Tamil Nadu.

3.2. *November*

3.2.1. *Storms and Depressions*

Two intense low pressure systems formed during the month, of which one formed as Depression (2nd-6th) over the southeast Bay of Bengal and the other as CS 'Nada' on the last day of the month over south Bay of Bengal. The Depression initially moved in northwest direction causing *fairly widespread* rainfall with *isolated heavy rainfall* over northern coastal parts of east coast and southern parts of northeast subdivisions. However, due to its re-curving in northeast direction, over the core region of NEM *i.e.*, south peninsula, rainfall activity continued to remain subdued.

3.2.2. *Weather and associated synoptic features*

A summary of the synoptic systems for the month of November 2016 is given in Table 3. The sub-divisionwise percentage departure of rainfall from normal and the significant amounts of rainfall during the month are given in Table 1 & 5 respectively.

The rainfall activity over the NEM core region remained subdued during the first week. Also, the subdued Western Disturbance (WD) activity led to advection of dry and cold air from the north leading to fall in minimum temperatures over parts of north, central and adjoining parts of Peninsular India during the second week. Towards the mid-month, the amplification of an easterly wave trough enhanced the rainfall activity over south Peninsula. It caused *scattered to isolated* rainfall over the core region of NEM with heavy to very heavy rainfall at isolated places in Tamil Nadu and Kerala. During the third week, subsidence and the lack of convective activity over the north Indian Ocean led to the establishment of an anomalous anticyclone in the lower troposphere over south peninsula. It resulted into subdued northeast monsoon activity. The systems in westerlies affecting the Indian region also remained feeble as the High-index phase of mid-latitude circulation caused the westerly systems to traverse more north. The MJO strengthened as it propagated eastwards across Indian Seas and enhanced the convective phase thereby resulting in the genesis of cyclonic storm 'Nada' over southeast Bay of Bengal. It did not affect the rainfall activity over the mainland but caused isolated to scattered rainfall over Andaman & Nicobar Islands during the last week.

The Madden-Julian Oscillation (MJO) strengthened and started propagating eastward across the Indian seas in the latter half of November It was in this enhanced convective phase that the cyclonic storm 'NADA' formed over south Bay of Bengal towards the end of the week. The crossing phase of this system caused *active* NEM conditions over Tamil Nadu for the first time during the season.

3.2.3. *Temperature*

Maximum temperatures were *normal to above normal* over most parts of India with *appreciably above normal* temeperature over parts of western Himalayan region and south Peninsula. It was *below normal* over *isolated* parts of east India.

Minimum temperatures were *normal to below normal* over most parts of the country with *appreciably below normal* in isolated parts of central, east and adjoining Peninsular India, except for extreme parts of north, northwest, north east and south Peninsula where the temperatures were *above normal*.

This November was the warmest month in respect of Maximum temperature for the homogenous region of south Peninsular India since 1971.

The month's lowest minimum temperature over the plains of the country was 6.5 ºC, recorded at

Narnaul (Haryana) during 17-19 November and on 29th November, 2016.

3.2.4. *Disastrous weather events and associated damage*

As per media reports, dense fog and poor visibility over parts of north and western Himalayan region led to rescheduling of flights over several airports. Poor visibility led to accident in Haryana and claimed 6 lives. Heavy rain led to landslips over several places over Nilgiri Mountain and disrupted the transport system.

3.3. *December*

3.3.1. *Storms and Depressions*

The large vertical wind shear and less thermal energy led to the weakening of the Cyclonic Storm '**Nada**' into a Deep Depression (DD) and Depression (D) over the Sea area and the system crossed Tamil Nadu coast near Nagapattinam as a Depression, in the early morning of 2nd. It did not produce much weather as a Cyclonic Storm, but during its crossing phase, it led to active northeast monsoon conditions over Tamil Nadu for the first time during this season. It caused widespread rainfall with *heavy* rainfall at *isolated* places over Tamil Nadu and *scattered* rainfall with *heavy* rainfall at *isolated* places over Andhra Pradesh.

Towards the later part of the week the upper level divergence over the eastern parts of north Indian Ocean and adjoining Maritime continent aided the formation of a D over southeast Bay of Bengal on 6th.

This depression moving northwards and west-northwards gradually intensified into a Very Severe cyclonic storm '**Vardah**'(6-13 December). It crossed Tamil Nadu coast close to Chennai as a Severe Cyclonic Storm (SCS) on 12th and weakened further into a well-marked low by the next morning. It created havoc over Chennai and adjoining districts of north Tamil Nadu but at the same time caused copious rainfall over the large deficient regions for a couple of days. It caused *heavy* to *very heavy* rainfall at many places over Tamil Nadu and at a few places over Andhra Pradesh and extremely heavy rainfall at isolated places over Tamil Nadu. It also caused isolated to scattered rainfall over Telangana and Kerala with isolated heavy to very heavy rainfall over Telangana and fairly widespread rainfall with isolated heavy rainfall over south interior Karnataka.Thereafter, moving westwards over the land it weakened further and emerged into the Arabian Sea as a low pressure area, and intensified into a depression over southwest Arabian Sea on 17th. It further moved west-southwestwards and weakened *in-situ* on 18th as it approached Somalia coast, encountering colder Sea Surface Temperatures and dry desert air. Being short-lived, it did not produce much influence on the weather over the region.

3.3.2. *Weather and associated synoptic features*

Table 4 gives a summary of the synoptic systems during the month of December 2016. The sub-divisionwise percentage departure of rainfall from normal and the significant amounts of rainfall during the month are given in Table 1 & 5 respectively.

The CS 'Nada' further weakened into a low pressure area over interior Tamil Nadu and neighbourhood by afternoon of 2nd. Moving westwards, it entered the Arabian Sea and lay over Lakshadweep and neighbourhood on 3rd. During its weakening stage into low pressure area, it caused *fairly widespread* rainfall with *heavy* rainfall at *isolated* places over Tamil Nadu and *scattered to isolated* rainfall over Andhra Pradesh, Telangana, south interior Karnataka and Kerala. The moisture incursion from the Bay of Bengal during the transition of month caused *isolated* rainfall over the parts of northeastern sub-divisions.

The WD activity mostly remained low (owing to High Index Phase) during the month except for a couple of days during mid and last week of the month. It led to subdued rainfall activity over the north and northwest India resulting into persistent fog conditions over the region. The dry and cold northerly wind caused *cold day* and *cold wave* conditions over north which extended upto adjoining sub-divisions of east and central India during the second and third week of the month.

Towards the end of the season, the systems in westerly wind regime led to *scattered to isolated* rainfall over western Himalayan region and the presence of a cyclonic circulation over the northeast caused *scattered to isolated* rainfall over the region for a couple of days.

3.3.3. *Temperature*

Maximum temperatures were *normal to above normal* over most parts of the country and *appreciably above normal* over parts of extreme north, northwest and north eastern region. They were *below normal* over most parts and *appreciably below normal* over isolated parts of Indo-Gangetic Plains.

Minimum temperatures were *normal to below normal* over most parts of central India and peninsular India and were *above normal* over the rest of the country with *appreciably above normal* over parts of north, north west and north east India.

Cold wave conditions prevailed on 9 days over Odisha; 1 to 3 days over Bihar, east Uttar Pradesh, east Madhya Pradesh, Vidarbha and Chhattisgarh.

TABLE 4

Details of the weather systems during December 2016

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.	Very severe cyclonic storm (Vardah)	6 (0900 UTC) - 13 (0000 UTC)	Southeast Bay of Bengal centred near Lat. 8.5° N/ Long. 91.0° E	North and then west	North interior Tamil Nadu centred near Lat. 12.5° N / Long. 78.0° E	It weakened into a well-marked low pressure area over interior Tamil Nadu and adjoining south interior Karnataka on 13 morning. Details are given in the article on Storms & Depressions over the north Indian Ocean-2017
(**B**)	*Deep Depression/Depression*					
1.	Deep Depression	2-6	Southwest Arabian Sea centred near Lat. 11.0° N/ Long. 62.5° E	West-southwest	Southwest Arabian Sea centred near Lat. 09.4° N / Long. 56.8° E	A remnant of cyclonic storm 'Vardah' crossed the peninsular India and emerged into the Arabian Sea as a low pressure area on 14. Details are given in the article on Storms & Depressions over the north Indian Ocean-2017
(**C**)	*Western disturbances/Eastward moving systems*					
(*i*)	*Upper air cyclonic circulation*					
1.	Mid tropospheric levels	10-13	Northeast Afghanistan and neighbourhood	Northeast	Jammu & Kashmir and neighbourhood	Initially it lay as a trough with its axis at 5.8 kms a.s.l. on 8 & 9 and as trough aloft on 10. It moved away northeastwards on 14
2.	Do	22-26	North Pakistan and neighbourhood	East-northeast	Eastern parts of Jammu & Kashmir and neighbourhood	It lay as a trough with its axis at 5.8 kms a.s.l. on 21. Moved away east northeastwards on 27
3.	Do	27-29	North Pakistan and adjoining Jammu & Kashmir	Do	Northern parts of Jammu & Kashmir and neighbourhood	The feeble WD moved away east northeastwards on 30
(*ii*)	*As a trough/ Trough in westerlies*					
1.	Mid tropospheric levels	15- 16	Along Long. 62° E to the north of Lat. 30° N (axis at 3.1 kms a.s.l.)	Northeast	Along Long. 73° E to the north of Lat. 35° N (axis at 3.1 kms a.s.l.)	It was feeble and moved away northeastwards on 17
2.	Lower tropospheric levels	17-19	Along Long. 56° E to the north of Lat. 30° N (axis at 3.1 kms a.s.l.)	Do	Along Long. 65° E to the north of Lat. 30° N (axis at 3.1 kms a.s.l.)	It lay as a cyclonic circulation over north Pakistan and adjoining Jammu & Kashmir on 20 and moved away northeastwards on 21
3.	Mid & upper tropospheric levels	26-27	Along Long. 88° E to the north of Lat. 25° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 92° E to the north of Lat. 20° N (axis at 5.8 kms a.s.l.)	Moved away eastwards on 28
(*iii*)	*As an induced cyclonic circulation*					
1.	At lower levels	9-12	Central Pakistan and adjoining west Rajasthan	East	Punjab and adjoining Haryana	Became less marked on 13
2.	Do	24-25	Northwest Rajasthan neighbourhood	Do	Haryana and neighbourhood	Became less marked on 26
(**D**)	*Other upper air cyclonic circulations*					
1.	At lower levels	6	Southeast Arabian sea and adjoining areas of Lakshadweep	Stationary	*In-situ*	Became less marked on 7
2.	Upto lower tropospheric levels	7-8	Jharkhand and neighbourhood	Quasi-stationary	Bihar and neighbourhood	Became less marked on 9

TABLE 4 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.	Between 1.5 & 2.1 kms a.s.l.	7	South Tamil Nadu and neighbourhood	Stationary	*In-situ*	Became less marked on 8
4.	Upto mid tropospheric levels	15-19	Gulf of Siam and neighbourhood	west	southwest Bay of Bengal and neighbourhood	Became less marked on 20
5.	Upto lower tropospheric levels	18	Bangladesh and adjoining Tripura	Stationary	*In-situ*	Became less marked on 19
6.	Do	22-25	Tripura and neighbourhood	East	Mizoram and neighbourhood	Moved away eastwards on 26
7.	Do	29 Dec 2016 -1 Jan 2017	South Bangladesh and neighbourhood	Do	Bihar and adjoining Sub- Himalayan West Bengal	Became less marked on 2 January, 2017
8.	Upto mid tropospheric levels	31 Dec 2016 - 4 Jan 2017	Northwest Rajasthan & neighbourhood	Do	Eastern parts of Bangladesh and neighbourhood	Became less marked on 5 January, 2017
(**E**)	*Trough in easterlies*					
1.	At mean Sea level	7	From Lakshadweep area to south Konkan coast	Stationary	*In-situ*	Became less marked on 8
2.	Upto lower levels	16-22	Tenasserim coast and adjoining south Andaman Sea	West	Southeast Arabian Sea and neighbourhood	It lay at mean sea level during 16-19 with a cyclonic circulation aloft extending upto mid tropospheric levels. Moved away westwards on 23
3.	At mean Sea level	21 Dec 2016 - 1 Jan 2017	Tenasserim coast	Do	Equatorial Indian Ocean and adjoining Maldives areas	Became un-important on 2 January, 2017
4.	Do	30 Dec 2016 - 3 Jan 2017	Tenasserim coast and neighbourhood	Do	Southeast Bay of Bengal and neighbourhood	A cyclonic circulation extending upto 3.1 kms a.s.l. lay embedded on 3. Became less marked on 4 January, 2017
(**F**)	*Other trough*					
1.	Upto lower tropospheric levels	5-6	Central Nepal to Bihar	Stationary	*In-situ*	Became less marked on 7
2.	At lower levels	21	From east Uttar Pradesh to Manipur across north Bihar, Sub-Himalayan West Bengal & Sikkim and Assam & Meghalaya	Do	Do	Became less marked on 22

Cold day conditions prevailed on 1 day over Bihar, Uttar Pradesh and Haryana, Chandigarh & Delhi.

'Leh' town recorded minimum temperature of *minus* 15.0 ^{o}C on 21st December.

The month's and seasons lowest minimum temperature in the plains of the country was 3.0 ^{o}C recorded at Amritsar (Punjab) and Narnaul (Haryana) on 26th & 27th December 2016.

3.3.4. *Disastrous weather events and associated damage*

According to media reports, cold wave related incidents claimed 32 lives in Bihar and 21 lives in Uttar Pradesh. Dense fog prevailed over north India which led to cancellation of trains. Fog related incidents claimed 6 lives in Uttar Pradesh. Cyclonic Storm 'Vardah' claimed 18 lives In Tamil Nadu. Around 6000 trees were uprooted

TABLE 5

Some representative amounts of rainfall in cm for October, November and December 2016 (5 cm and above)

Date	Some representative amounts of rainfall in cm for October, November and December 2016 (5 cm and above)
1 Oct	Jukkal 20, Madnur 16, Bidar 14, Koppal PTO, and Narayankhed 12 each, Santhapur, Renapur, Dabaka, Aurad and Ambagarh Chowki 9 each, Amraghat and Balkonda 8 each; Pottangi, Birkoor, Jiyyamma Valasa and Degloor-FMO 7 each, Chittapur, Koraput, Ahmedpur, Bhokar, Lakhipur, Dholai, Daspalla, Dhar, Dhar-AWS, Banswada, Repalle, Billoli, Ambadola, Sukma, Dowleshwaram and Chottabekra 6 each, Jaipur, Manawar, Chakur, Maheshwar, Mudhole, Kotgiri, Ranastalam, Kukatpally Jntu (Arg), Pitlam, Nuzvid, Avanigada, Dindori-AWS, Paralakhemundi, Vuyyuru AP, Kaptipada ARG, Sorada, Petlawad, Mulchera, Samakhunta AWS, Gudivada, Udaipura, Prathipadu, Gunupur, Kandhar, Araku Valley and Kurwai 5 each
2 Oct	Osmanabad14, Renapur and Patoda 12 each, Tuljapur 11, Chakur 10, Ambejogai / Mominabad, Mukhed, Madnur, Paralakhemundi, Garividi, Bhungra, Madha, Pen and Latur 9 each, Sudhagad Pali and Tala 8 each, Lingampet, Roha, Bhum, Alibag, Uran, Vadgaon Maval, Nanded, Utnur and Ahmedpur 7 each, Hingoli-Hyd, Pune (Lohegaon), Karjat, Danpur, Pipalkhunt, Manvat, Medak, Tadwai, Tentulikhunti ARG, Port Blair, Padegaonagri, Sajjangarh, Shirur Ghodnadi and Bhabhra 6 each, Barshi, Murtajapur, Wai, Purna, Sengaon, Bhor, Dahiwadi Man, Velhe, Washi, Baripada, Arthuna, Dharur, Shriwardhan, Khed Rajgurunagar, Bhiknur, Bhira, Shrigonda, Kallamb, Solapur, Mahabaleshwar, Mangaon, Khandala Bavda, Washim, Saintala ARG, Bhuban ARG, Mandasa, Indapur, Makloor, Garhi, Pathapatnam, Naraj, Jamkhed, Degloor-FMO, Shahabad, Satara and Cheepurupalle 5 each
3 Oct	Shrirampur 13, Ghansawangi, Valod, Ashti, Rahuri and Nancowry 9 each, Shevgaon, Jambughoda, Barshi, Sengaon and Dapoliagri 7 each, Harnai, Ahmednagar, Kallamb, Ladnoo, Mandangad, Mahuva, Bardoli, Songadh and Shriwardhan 6 each, Olpad, Nandgaon, Gangapur, Osmanabad, Pathardi, Desaiganj, Sakri, Gudivada, Kalvan, Sindkheda, Kopargaon, Sheoganj, Khirkiya -Arg and Wakwali agri 5 each
4 Oct	Harnai 13, Surat and Patoda 10 each, Botad 9, Babra and Wakwali agri 8 each, Dangs (Ahwa), Junagadh, Gadhda, Valod, Peth, Guhagarh, Taibpur, Alipurduar CWC, Dapoliagri, Pathardi, Madha and Khed 7 each, Palsana, Tribeni / Balmiki, Devgadh Baria, Jesar, Bavla, Bhuj AP, Subir, Malegaon, Chalisgaon and Parner 6 each, Dindori, Matar, Jetpur, Palamaner, Dhadgaon / Akrani-Hydro, Dindigul ARG, Falakata, Rania, Uchchhal, Tankara, Rahuri, Dholka, Sanchore, Umrala, Petlawad, Gudari, Junagarh, Dhoraji and Wadhvan 5 each
5 Oct	Bhachau 18, Lodhika 16, Lalpur 15, Vanthali and Junagadh 14 each, Suigam, Dharoi Colony and Kutiana 13 each, Tankara 12, Samayapuram, Dhrol ARG, Pullambadi, Dhrol and Thanjavur 11 each, Baruch 10, Kalol, Jamkandorna and Sathanur Dam 9 each, Radhanpur, Karjan, Dhanera, Rapar, Mannargudi, Papanasam and Rajpipala 8 each, Vadia, Anakapalle, Nandod, Deeg, Ambikapur, Olpad, Madhbun, Kamalpur, Jodia and Dahanu 7 each, Kodavasal, Ankleshwer, Jamjodhpur, Talala, Tirukattupalli, Hazaribagh, Raniwada, Taranagar / Reni, Choryasi, Lalgudi, Nagrarfort, Jhagadia, Tilakwada, Harnai, Khed, Mandangad, Shriwardhan, Kallakkurichchi, Valangaiman, Deodar, Modasa, Balasinor and Khambhat 6 each, Port Blair, Srikalahasti, Bhinmal, Pachpadra, Khambhalia, Jiyyamma Valasa, Halol, Vaijapur, Kotdasangani, Jatusana, Bhesan, Rajsamand, Thanjavur PTO, Kishangarh, Faridabad, Sayla, Bhabhar, Shahera, Thottambedu, Jetpur, Wokha AWS, Malakhera, Mangrol, Rohat, Pushkar, Chanasma and Bhiwandi 5 each
6 Oct	Kaiserganj 13, Rajkishorenagar 12, Arai, Bayana and Visavadar 10 each, Satlasana 9, Malia, Bhanjnagar, Bari ARG, Chilaghat and Nathdwara 8 each, Ajmer, Kekri, Nandigram, Pindwara, Nawabganj Tehsil, Ajmer Tehsil, Kalna, Gogunda, Khalilabad and Bhinay 7 each, R.Udaigiri, Durgachak, Bara Banki, Maliamiana, Begu, Balrampur, Biaora, Sawaimadhopur Tesil, Chanderi, Paratwada, Geola, Nasirabad, Srinagar and Dahegam 6 each, Gonda Cwc, Kutiana, Seethanagaram, Auraiya Cwc, Tekkali, Pisagan, Sarwar, Madurai City, Madurai South, Bhograi, Bhainsdehi, Mankar, Paradip, Sawai Madhopur, Kanva, Phagi, Vijaynagar, Kalol, Mahudha, Mahemdavad, Lathi, Tikamgarh-AWS, Garudeshwar, Merakamudidam, Kankrej, Beir, Vanthali, Bhadravati, Pachrukhi, Danta, Anjar, Kalyanpur, Keshod and Mettupatti 5 each
7 Oct	Jagannath Prasad ARG 15, Garadapur ARG and Chhamonu 12 each, Marsaghai ARG 11, Alipingal and Komna 10 each, Sorada, Ganjbasoda, Paderu and Khurai 9 each, Kotagarh, Odagaon ARG, Raikia ARG, Purushottampur, Bheemunipatnam and Mangrol 8 each, Danpur, Dharmagarh ARG, Forbesganj, Sapaul, Niali ARG, Dondilohara, Jaipatna, Narsinghpur, Jagatsinghpur AWS and Singrauli-AWS 7 each, Dahegam, Kadi, Amreli, Shahabad, Tentulikhunti ARG, Kosagumda, Digha, Pathapatnam, Gopalpur and Denkada 6 each, Amarpur, Gokulpur AWS, Matar, Lilia, Savarkundla, Bargarh, Madhabarida, Udaipur, Aska, Hindol, Chhatrapur, Kesinga ARG, Bayad, Kendrapara, Naktideul, Ullunda ARG, Perseoni, Jhadol, Krishnaprasad, Salekasa, Vepada, Titlagarh, Digapahandi ARG and Muniguda ARG 5 each
8 Oct	NH31 Bridge 14, Ramagundam 13, Madhipura 12, Daudnagar 11, Gandhwani, Hasimara and Arwal 10 each, Julapalle, Tribeniganj, Mallial, Mancherial, Bramhapuri, Desaiganj and Sultanabad 9 each, Bhimnagar, Luxettipet, Perseoni, Champasari, Goibargaon, Araria, Jalpaiguri, Kumargram and Nagbhir 8 each, Eturnagaram, Chengmari / Diana, Baghdogra AP, Keshod, Armori and Domohani 7 each, Khanapur, Veeraghattam, Ajaigarh, Sirsilla, Ghorawal, Samudrapur, Enkuru, Saoli, Garubathan, Pottangi, Kokrajhar, Patna AP, Birpur, Vizianagaram and Dharmapuri 6 each, Nirmali, Jagtial, Chandrugonda, Amalapuram, Bhikangaon, Gajoldoba, Mangrol (J), Arjuni Morgaon, Utnur, Manthani, Mendarda, Madanpur Rampur, Taibpur, Kodinar, Sutrapada, Visavadar, Mohitnagar, Bhopalpatnam, Anakapalle, Narayanpur, Veraval, Nellimarla, Bara, Karimnagar, Binika, Adilabad, Bansgaon, Thimmapur, Islampur, Tekulapalle, Pegadapalle, Chipabarod, Malia, Mustabad and Mogullapalle 5 each

TABLE 5 (*Contd*.)

Date	Some representative amounts of rainfall in cm for October, November and December 2016 (5 cm and above)
9 Oct	Karimganj 23, Burgampadu 20, Titlagarh 19, Daudnagar 17, Buxar 13, Tuting 12, Annapurnaghat, Rosera and Hayaghat 11 each, Deo, Hingoli-Hyd, Balumath and Kondagaon 10 each, Williamnagar, Belgaon, Rafiganj, Kothagudam and Moranhat 9 each, Hasanpur, Korpana, Ekangersarai, Kishanganj, Passighat, Roing and Phiringia ARG 8 each, Birkoor, Patnagarh, Gaya AP, Mawsynram, Sadakarjuni, Khaprakhol ARG, Nuagada ARG, Dharamtul, Dornakal, Dholla Bazar, Amraghat, Bodh Gaya, Palam, Silchar, Jagdalpur, Varni and Raikia ARG 7 each, Neamatighat, Tekulapalle, Kotgiri, Umari, Santhapur, Jandhaha, Palawancha, Gotegaon, Govindaraopet, Mahendragarh, Amarkantak, Dummugudem, Samastipur, Itanagar, Chauldhowaghat, Mahur, Lohardaga, Chottabekra, Pendra, Tikabali, Mahasamund, Degloor-FMO, Ranjal, Chinsura, Humnabad, Williamnagar AWS and Chimur 6 each, Julurpad, Nanded, Sillod, Balod, Joypur, Enkuru, Nalhati, Aurangabad, Pauni, Kesinga ARG, Kallamnuri, Kodawanpur / C.Bii, Wani, Turekela, Pusad, Madnur, Ambagarh Chowki, Sultanpur Cwc, Kothagudem, Daltonganj, Jukkal, Nizam Sagar, Banswada, Chandel AWS, Muktainagar / Edalabad, Bhamragad, Parbhani, Sakoli, Dhaurahara, Paratwada, Chandrugonda, Anini AWS, Nongstain AWS, Bhograi, Kheri Lakhimpur, Maregaon and Kamalapur 5 each
10 Oct	Baghmara AWS 13, Dumri, Sherghati and Koner 11 each, Roing and Lanjigarh 10 each, Ratnagiri, Mawsynram and Valpoi 9 each, Nawada, Aurangabad, Kankavli, Sawantwadi and Bemetara 8 each, Barbigha, Rajapur, Radhanagari, Vengurla, Dodamarg, Passighat, Raidih, Katihar and Alipurduar CWC 7 each, Batagaon, Tilaiya, Bhograi, Anini AWS, Malvan, Panki, Kudal, Kotagarh, Palmerganj, Gangarampur, Tekari, Batli ARG and Mulde Agri 6 each, Rajnandgaon, Vaibhavwadi, Devgarh, Kumta, Panjim (Goa), Pallahara, Gondpipri, Ponda, Ambadola, Panposh, Dhengraghat, Gersoppa, Gaya AP, Namsai, Kusumanchi, Kadra, Faizabad, Alipurduar, Sheikhpura, Mulchera, Saintala ARG, Mapusa, Manki, Chanchal, Rameshwaragri and Manthani 5 each
11 Oct	Ankola 31, Cherrapunji (Rkm) 18, Sagar 17, Amtala 15, Chauldhowaghat 13, Deganga, Cherrapunji and Mawsynram 12 each, Williamnagar and Karwar 11 each, Margherita 9, Kantapada ARG, Roing, N. Lakhimpur and Williamnagar AWS 8 each, Astaranga ARG, Kadra, Suri Cwc and Kumta 7 each, Dhemaji AWS, Canacona, Garubathan and Buxaduar 6 each, Nongstain AWS, Kancheepuram, Tensa, Kolkata, Kansabati Dam, Hungund, Baghmara AWS, Ramgarh, Palasamudram, Gersoppa, Anini AWS, Itanagar, Champasari and Athmalik 5 each
12 Oct	Sevoke 18, Salbari 17, Alipurduar CWC, Siliguri ARG and Bagrakote 15 each, Champasari 14, Kumargram 12, Taibpur 11, Sirkali, Pedong and Kallakkurichchi 10 each, Garubathan, Darjeeling, Mohitnagar and Sawantwadi 9 each, Gangarampur, Kalingpong, Dharmapuri, Dharmapuri PTO, Singla Bazar, Margherita and Dhubri Cwc 8 each, Dillighat, Hasimara, Mulki, Magadi, Gajoldoba, Gossaigaon, Chepan, Nagarkata, Alipurduar, Honavar, Barobhisha and Kokrajhar 7 each, Malbazar ARG, Majbhat, Agumbe, Domohani, Chitradurga, Chengmari / Diana, Sukiapokhri and Chanchal 6 each, Harur, Damthang, Hosadurga, Namthang, Jalpaiguri, Thakurganj, Anaikaranchatram (Kollid)), Anekal, Baghdogra AP, Panjim (Goa), Dhubri, Galgalia, Sabroom, Nh31 Bridge, Roing, Along AWS, Basar, Belonia, Tuting, Cherrapunji (Rkm), Panhala and Barur 5 each
13 Oct	Cherrapunji (Rkm) 26, Mawsynram 19, Cherrapunji 18, Garubathan 12, Tirukoilur and Thirukoilur ARG 10 each, Sankarapuram, Channapatna, Darjeeling, Malavalli and Vilupuram 9 each, Sukiapokhri and Goalparacwc 8 each, Kancheepuram, Beki Mathungari, Goalpara, Sevoke, Tuting and Tirukattupalli 7 each, Daporijo, Mathabhanga, Bengaluru Kial, Sathanur Dam, Dhubri Cwc, Devanahalli, Kumargram, Kokrajhar and Itanagar 6 each, Chepan, Salbari, Champasari, Kampur, Bagrakote, Maddur, Gossaigaon, Galgalia, Hoskote, Melabazar / Matunga, Along AWS, Kollegal, Krishnarajpet, Salem and Basar 5 each
14 Oct	Sattur and Nilakottai 12 each, Chengmari / Diana, Malbazar ARG, Kochi AP and Salbari 11 each, Peraiyur, Siliguri ARG, Periyakulam, Baghdogra AP and Enamakkal 10 each, Periyakulam AWS and Andipatti 9 each, Vadipatti, Kovilankulam, Udumalpet, Mulanur, Irikkur, Sivakasi, Ernakulam South, Gajoldoba and Peermade To 8 each, Champasari, Vaikom, Sevoke, Sukiapokhri, Palani, Tiruppur, Pollachi, Idukki, Pookot and Pedong 7 each, Dharapuram, Piravam, Usilampatti, Bagrakote, Vythiri, Barur, Watrap, Neora, Murti, Coonoor and Coonoor PTO 6 each, Srivilliputhur, Mattanur, Kodaikanal, Garubathan, Mettupalayam, Ottapalam, Aruppukottai, Kodungallur, Sholavandan, Nagarkata, Darjeeling, Naduvattam, Ballari AWS and Kangeyam 5 each
15 Oct	Natham 10, Medikeri 8, Aryankavu, Amini Divi, Karipur and Perumpavur 5 each
16 Oct	Konni 11, Kottayam 8, Chengannur 6, Ottapalam 5
17 Oct	Punalur 11, Car Nicobar 8, Car Nicobar IAF 7, Kurudamannil 5
18 Oct	Car Nicobar 6, Hut Bay 5
19 Oct	Nanguneri 6
20 Oct	Piravam, Samayapuram, Car Nicobar and Maya Bandar 5 each
21 Oct	Mulanur and Chatrapatti (Odanchatra) 8 each, Erode and Kumarapalayam 7 each, Tiruvadanai, Kayamkulam Agri, R.S.Mangalam, Vedasandur, Kangeyam, Kayamkulam and Peraiyur 5 each
22 Oct	Sholavandan 10, Mancompu 9, Usilampatti, Peraiyur and Alappuzha 8 each, Kayamkulam and Vadipatti 7 each, Kottayam, Kayamkulam Agri, Nilakottai, Surangudi, Gandarvakottai and Tirumangalam 5 each
23 Oct	Tirumayam 6
24 Oct	Grand Anaicut and Angadipuram 7 each, Lalgudi 5

TABLE 5 (*Contd*.)

Date	Some representative amounts of rainfall in cm for October, November and December 2016 (5 cm and above)
25 Oct	Nil
26 Oct	Nil
27 Oct	Digha 10, Sabong, Bongaon and Udala 9 each, Kumarakom, Pechiparai, NH5 Gobindpur, Rajghat and Kochi AP 8 each, Jaipur, Balasore, Jaleswar and Remuna ARG 7 each, Balimundali and Bhograi 6 each, Anandpur, Contai, Amta, Chinsura, Dhamnagar ARG, Nilgiri, Pingla, Kaptipada ARG and Bonth 5 each
28 Oct	Williamnagar 8, Dholai and Visakhapatnam 7 each, Williamnagar AWS and Mawsynram 6 each
29 Oct	Chalakudi 9, Vadakkancherry 7
30 Oct	Malkangiri 9, Kothagudem and Narsampet 8 each, Tiruvaiyaru 7, Tozhudur, Valangaiman and Perambalur 6 each, Amarpur, Musiri, Sullurpeta, Tada, Kusumanchi, Parvathipuram and Chennaraopet 5 each
31 Oct	Udumalpet and Vadipatti 12 each, Pollachi 11, Pechiparai 10, Punalur 9, Tirumayam and Hut Bay 8 each, Tirupathur, Konni, Kovai / Koyamutthur AP, AP Peelamedu and Ottapalam 7 each, Tiruppur, Sendurai, Maniyachi, Thodupuzha, Avinasi, Port Blair, Arimalam and Karaikudi 6 each, Natham, Sholavandan, Gudurwrgl, Chatrapatti (Odanchatra), Periyanaickenpalayam, Palani, Alathur, Kollamkode, Mancompu and Karipur 5 each
1 Nov	Punalur 10, Papanasam 8, Halli Mysuru, Napoklu, Thoothukudi, Thenkasi and R.S.Mangalam 5 each
2 Nov	Punalur and Thodupuzha 9 each, Ponneri 8, Maya Bandar, CIAL Kochi, Kochi AP, Satankulam, Kayamkulam Agri and Ernakulam South 6 each, Long Islands, Kottayam and Bhagamandala 5 each
3 Nov	Nagapattnam 14, Karaikal 11, Aryankavu, Long Islands and Mylaudy 6 each, Kottayam, Kumarakom, Thiruthuraipoondi, Satankulam, Kodavasal, Mayiladuthurai and Kkl Surakudi Kvk 5 each
4 Nov	Konni 10, Kalingapatnam 9, Contai, Kangeyam, Mandasa and Rameswaram 7 each, Jajpur and Punalur 6 each, Sompeta, Astaranga ARG, NH5 Gobindpur, Amta, Nilgiri, Tirtol ARG, Nandigram, Arundhutinagar and Piravam 5 each
5 Nov	Tirtol ARG and Paradip 10 each, Marsaghai ARG and Karimganj 9 each, Astaranga ARG, Derabis ARG, Chandbali, Garadapur ARG and Thiruchuzhi 8 each, Balikuda ARG, Kendrapara, Kujanga ARG and Rajkanika 7 each, Aryankavu, Alipingal, Jagatsinghpur AWS, Pattamundai, Kantapada ARG, Satyabadi ARG, Puri and Binjharpur ARG 6 each, Gop, Kamudhi, Niali ARG, Nimpara, Kamudhi ARG, Raghunathpur ARG, Basudevpur AWS, Amraghat and Rajapalayam 5 each
6 Nov	Arundhutinagar 13, Khowai, Agartala AP and Kailashahar 12 each, Kamalpur and Bishalgarh 11 each, Gokulpur AWS and Udaipur 10 each, Belonia, Sonamura, B P Ghat and Karimganj 9 each, Sabroom 8, Aizawal and Haflong 7 each, Kampur, Dharmanagar / Panisagar and Lengpui 6 each, Amarpur and Matijuri 5 each
7 Nov	B P Ghat 13, Gokulpur AWS, Udaipur, Amarpur and Bishalgarh 11 each, Khowai and Haflong 10 each Wokha AWS, Kailashahar, Karimganj and Belonia 8 each, Chhamonu, Lumding and Jharnapani 7 each, Matijuri, Bokajan and Sonamura 5 each
8 Nov	Nil
9 Nov	Bhoothapandy and Tawang AWS 5 each
10 Nov	Nil
11 Nov	Nil
12 Nov	Cherthala 9, Alappuzha 5
13 Nov	Nannilam 8
14 Nov	Coonoor PTO 12, Coonoor 11, Kurudamannil 7
15 Nov	Coonoor 14, Coonoor PTO 13, Vilathikulam 7, Linganamakki HMS 6, Thalaguppa and Kammardi 5 each
16 Nov	Linganamakki HMS 6, Margao and Arasalu 5 each
17 Nov	Kvk Kattukuppam ARG 5
18 Nov	Nil
19 Nov	Nil
20 Nov	Pamban 5
21 Nov	Vedaranniyam 5
22 Nov	Satankulam 5
23 Nov	Nil

TABLE 5 (*Contd*.)

Date	Some representative amounts of rainfall in cm for October, November and December 2016 (5 cm and above)
24 Nov	Ernakulam South 5
25 Nov	Nil
26 Nov	Nil
27 Nov	Nil
28 Nov	Nil
29 Nov	Nil
30 Nov	Nil
1 Dec	Vedaranniyam 5
2 Dec	Mahabalipuram 11, Gudur 9, Cholavaram and Red Hills 6 each, Sullurpeta, Satyabama Uty ARG, Kodur, Muthupet, Srikalahasti, Venkatagiri, Thottambedu, Tada and Shar 5 each
3 Dec	Kolapakkam ARG and Virudhunagar 8 each, Madurai AP, Chennai AP, Sivakasi, Tirupuvanam, Tiruttani, Kancheepuram, Chengalpattu, Mettupatti and Tirumangalam 7 each, Satyabama Uty ARG, Chembarabakkam, Virinjipuram AWS and Poonamallee 6 each, Chembarambakkam ARG, Anna University, Anna Uty ARG, Kvk Kattukuppam ARG, Vellore and Paramakudi 5 each
4 Dec	Nancowry 13, Kodur 9, Car Nicobar IAF 8, Car Nicobar 7, Sivagiri 6, Coonoor and Coonoor PTO 5 each
5 Dec	Car Nicobar IAF and Car Nicobar 13 each, Hut Bay and Tirupathi AP 7 each, Nancowry6 , Puducherry and Pullampeta 5 each
6 Dec	Car Nicobar IAF 12, Car Nicobar, Hut Bay and Nancowry 9 each, Port Blair 5
7 Dec	Hut Bay 17, Port Blair 12, Maya Bandar 9, Car Nicobar IAF 7, Car Nicobar 5
8 Dec	Long Islands 23, Port Blair 21, Car Nicobar IAF 7, Nancowry 6, Car Nicobar 5
9 Dec	Maya Bandar 16, Long Islands 9, Srivilliputhur 7, Port Blair and Rajapalayam 5 each
10 Dec	Maya Bandar 7, Long Islands 5
11 Dec	Nil
12 Dec	Chennai city 6, Chennai AP, Puzhal ARG, Poonamalle ARG, Dgp Office, Satyabama Uty ARG, Anna University and Chembarambakkam ARG 5 each
13 Dec	Satyabama Uty ARG 38, KVK Kattukuppam ARG 34, Kancheepuram 28, Kalavai AWS 23, Poonamallee 22, Chembarabakkam 21, Chennai AP 20, Sriperumbudur 17, Chembarambakkam ARG 16, Yercaud, Tirumalla AP and Alangayam 15 each, Puttur and Tambaram 14 each, Atmakur 13, Nagari, Vinjamur, Chennai city and Thiruvalangadu 12 each, Anjatti, Arakonam, Cholavaram, Udayagiri, Vellore, Red Hills, Tiruvallur and Cheyyar 11 each, Chittoor, Ambur, Chengalpattu, Kodur, Poonamalle ARG, Kaveripakkam, Tiruttani, Satyavedu, Arani and Dgp Office 10 each, Sullurpeta, Anna University, Anna Uty ARG, Kandukur, Ponneri, Thamaraipakkam, Venkatagiri Kota, Palasamudram, Melalathur and Poondi 9 each, Kaveli, Nellore, Tirupathur PTO, Mahabalipuram, Anekal and Veligandla 8 each, Uthiramerur, Nambulipulikunta, Tirupattur, K G F AWS, Rapur, Thottambedu, Tirupathi AP, Maduranthagam, Gudur, Atlur, Rajampet, Krishnagiri, Mandapalle, Venkatagiri, Shar, Bengaluru AP, Bengaluru Hal AP, Shoolagiri, Hosur, Vandavasi, Hoskote, Marakkanam, Vaniaymbadi, Kuppam, Pakala, R.K.Pet, Gudiyatham, Cheyyur, Rayalpadu, Sambepalle and Royachoti 7 each, Lakkireddipalle, Pochampalli, Tada, Srikalahasti, Bengaluru CO, Bengaluru City, Gurramkonda, Pallipattu, Penucondapuram, Pullampeta, Barur, Thambalapalle, Badvel, Penagaluru and Palamaner 6 each, Wallajah, Punganur, Santhipuram, Tindivanam, Uthangarai, Kolar Gold Field, Ramanagara, Kadapa, Vempalle, Mylam AWS, Thali, Arogyavaram, Gingee, Kadiri, Tanakal, Channapatna and Thondebhavi 5 each
14 Dec	Kandukur 16, Veligandla and Marripudi each 7, Attur and Ponnampet Pwd 6 each
15 Dec	Agathi 9, Coonoor and Coonoor PTO 7 each, Pookot and Dharapuram 5 each
16 Dec	Nil
17 Dec	Hut Bay 6
18 Dec	Nil
19 Dec	Nil
20 Dec	Nil
21 Dec	Arantangi 7, Pattukottai 5
22 Dec	Nil

TABLE 5 (*Contd*.)

Date	Some representative amounts of rainfall in cm for October, November and December 2016 (5 cm and above)
23 Dec	Nancowry 7
24 Dec	Car Nicobar IAF 6, Car Nicobar 5
25 Dec	Hut Bay 5
26 Dec	Nil
27 Dec	Nil
28 Dec	Nil
29 Dec	Nil
30 Dec	Nil
31 Dec	Nil

leading to disruption of power supply and communication system in Tamil Nadu. In the formative stage of the storm, 2400 tourists were stranded in Havlock Islands.

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	- 07-11 cm.
Very heavy rainfall	- 12-20 cm.
Extremely heavy rainfall	- 21 cm or more.
Heavy snowfall	- 64.5 cm to 115.5 cm.

(*iii*) *Spatial distribution (percentage of the stations in a meteorological sub-division reporting a 24 hour rainfall of 0.1 mm or more)*

At most places (Widespread)	- (76-100)% of stations gets rainfall.
At many places (Fairly widespread)	- (51-75)% of stations gets rainfall.
At a few places (Scattered)	- (26-50)% of stations gets rainfall.
At isolated places (Isolated)	- ≤25% of stations gets rainfall.

(B) Monsoon activity

(*i*) *Southwest monsoon*

Vigorous	- Rainfall exceeding 4 times the normal with, at least two stations reporting rainfall more than or equal to 8 cm along the west coast and 5 cm elsewhere. Rainfall in that sub-division should *be fairly widespread or widespread.*
Active	- Rainfall more than 1½ to 4 times the normal, with at least two stations reporting rainfall more than or equal to 5 cm along the west coast and 3 cm elsewhere. Rainfall in that sub-division should be fairly *widespread or widespread*.

(*ii*) *Northeast monsoon*

Vigorous	- Rainfall exceeding 4 times the normal with at least two stations reporting rainfall more than or equal to 5 cm in coastal Tamil Nadu and south coastal Andhra Pradesh and 3 cm elsewhere in the northeast monsoon region. Rainfall in that sub -division should be *fairly widespread or widespread.*

Active	- Rainfall more than 1½ to 4 times the normal, with at least two stations reporting rainfall more than or equal to 3 cm in coastal Tamil Nadu and south coastal Andhra Pradesh and 2 cm elsewhere in the northeast monsoon region. Rainfall in that sub -division should be *fairly widespread or widespread.*

(C) Temperatures

(*i*) *Maximum / Day temperature*

Markedly above normal	- Departure from normal is ≥5 °C (where the normal maximum temperature is 40 °C or less).
Appreciably above normal	- Departure from normal is 3.1 °C to 5.0 °C (where the normal maximum temperature is 40 °C or less).
Above normal	- Departure from normal is 1.6 °C to 3.0 °C.
Normal	- Departure from normal is -1.5 °C to 1.5 °C.

(*ii*) *Minimum / Night temperature*

Cold wave conditions	- Cold wave is considered when minimum temperature of a station is 10 ^{o}C or less for plains and 0 °C or less for Hilly areas. 1. *Based on departure* Negative departure from normal is 4.5 °C to 6.4 °C. 2. *Based on Actual Minimum Temperature (For plain stations only)* When minimum temperature is ≤04 °C.
Severe cold wave conditions	- 1. *Based on departure* Negative departure from normal is more than 6.4 °C. 2. *Based on Actual Minimum Temperature (For plain stations only)* When Minimum temperature is ≤02 °C.
Cold day conditions	Cold day should be considered when minimum temperature of a station is 10 °C or less for plains and 0 °C or less for Hilly areas. Maximum temperature departure is -4.5 °C to 6.4 °C.
Markedly below normal	- Departure from normal is -5 °C or less (where the normal minimum temperature is 10 °C or more).
Appreciably below normal	- Departure from normal is between -3.1 °C to -5.0 °C (where the normal minimum temperature is 10 ^{o}C or more).
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.