MAUSAM, **65**, 1 (January 2014), 137-146

Weather in India

WINTER SEASON (January-February 2013)†

1. Introduction

The winter season-2013 was characterized by cold January and wet February with some new all time records of lowest minimum & highest maximum temperatures and 24 hours rainfall amounts during the two months' period. The country was affected by a sequence of active Western Disturbances (WDs), causing heavy snow and rains in hilly regions, which resulted in record breaking cold and foggy conditions in the plains.

The northeast monsoon rains ceased over Tamil Nadu, Kerala and adjoining parts of Andhra Pradesh and Karnataka on 11th January 2013, when the northern hemispheric near equatorial trough retreated further to the south and lay dormant close to the equator over the Indian region.

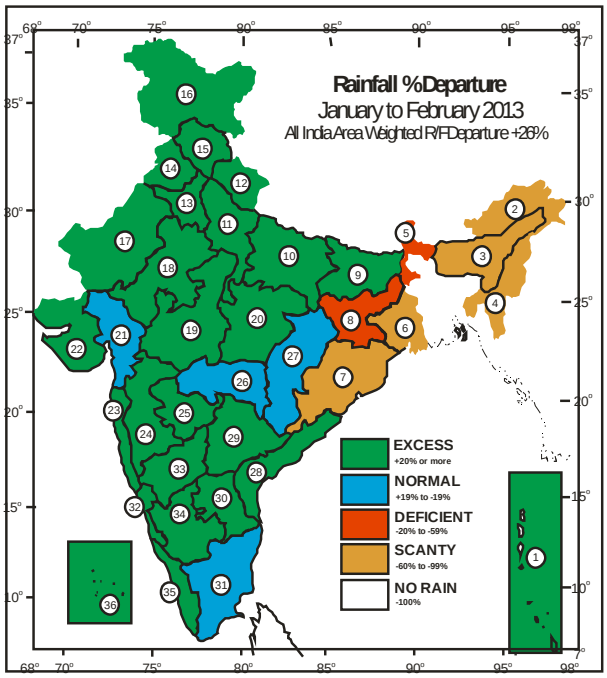
Dense fog prevailed over north and northeast India throughout January. Cold wave conditions continued unabated from the last week of December 2012, until the first fortnight of January 2013.

From the second fortnight of January till the end of the season, the core of Sub-Tropical Westerly Jet (STWJ) was seen between Lat. 23 °N to Lat. 30 °N, allowing the systems in westerlies to traverse through more southern latitudes. At times confluence of westerly and easterly wind regimes gave rise to precipitation over major parts of central and peninsular India. Parts of east and Northeast India received *scanty* rainfall during the season.

The National Capital, New Delhi, recorded a temperature of 1.9 °C on 6th January, the lowest in 44 years and a 71-year-old record was broken when Delhi recorded its wettest 24-hour spell of February rain (4.6 cm) on 5th February, in association with a Western Depression.

2. Seasonal Rainfall (January-February)

The seasonal sub-divisionwise rainfall (actual, normal & percentage departure) are given in Table 1. Out of the 36 met-subdivisions of India, the seasonal rainfall was *excess* in 25, *normal* in 4, *deficient* in 2 and *scanty* in 5 sub-divisions. The percentage departures falling under various categories, *viz*., *excess*, *normal*, *deficient* and *scanty* are shown in Fig. 1.



EXCESS - 25 NORMAL - 04 DEFICIENT - 02 SCANTY - 05 NO RAIN - 00

Fig. 1. Sub-divisionwise seasonal rainfall departure from normal (%) for winter season (January to February 2013). 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	26	**7**	-65	**13**	122	**19**	141	**25**	60	**31**	13
2	-60	**8**	-43	**14**	20	**20**	29	**26**	14	**32**	2043
3	-77	**9**	20	**15**	28	**21**	-4	**27**	5	**33**	87
4	-87	**10**	128	**16**	21	**22**	250	**28**	111	**34**	141
5	-56	**11**	169	**17**	311	**23**	1466	**29**	202	**35**	88
6	-63	**12**	146	**18**	120	**24**	181	**30**	236	**36**	71

Climatologically, the WDs move from west to east towards northeast India after traveling across the northern states, *viz*., Jammu & Kashmir, Punjab, Haryana, Himachal Pradesh and Uttarakhand. These systems, on interacting with the regional synoptic situations and topography of the region, give rise to precipitation over northwest and northeastern parts of the country during winter season. In contrast to last year, the impact of

* *Definition of terms in 'italics' other than subtitles are given in Appendix.*

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TABLE 1

Sub-divisionwise rainfall (mm) for each month and season as a whole (January-February 2013)

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	67.1	53.7	25	37.6	29.2	29	104.7	82.9	26
2.	Arunachal Pradesh	18.5	50.1	-63	40.5	98.0	-59	59.0	148.1	-60
3.	Assam & Meghalaya	1.1	16.4	-93	9.5	30.5	-69	10.6	46.9	-77
4.	Naga., Mani., Mizo. and Tri.	0.2	13.7	-99	5.7	30.3	-81	5.9	44.0	-87
5.	Sub-Himalayan West Bengal & Sikkim	3.0	26.6	-89	23.6	33.7	-30	26.7	60.3	-56
6.	Gangetic West Bengal	2.4	13.5	-82	10.5	20.9	-50	12.9	34.4	-63
7.	Orissa	3.3	10.8	-69	7.8	21.0	-63	11.2	31.8	-65
8.	Jharkhand	1.1	16.1	-93	17.9	17.3	3	19.0	33.4	-43
9.	Bihar	5.1	13.3	-61	22.6	9.7	133	27.7	23.0	20
10.	East Uttar Pradesh	6.1	16.8	-64	59.7	12.1	394	65.9	28.9	128
11.	West Uttar Pradesh	21.1	18.2	16	68.6	15.1	354	89.7	33.3	169
12.	Uttaranchal	73.0	52.1	40	188.3	54.1	248	261.3	106.2	146
13.	Haryana, Chandigarh & Delhi	21.1	17.8	18	52.1	15.1	245	73.2	32.9	122
14.	Punjab	9.3	25.2	-63	50.1	24.3	106	59.4	49.5	20
15.	Himachal Pradesh	75.6	97.5	-23	174.2	98.0	78	249.8	195.5	28
16.	Jammu & Kashmir	71.6	95.7	-25	185.4	117.2	58	257.1	212.9	21
17.	West Rajasthan	8.6	2.9	198	21.8	4.5	383	30.4	7.4	311
18.	East Rajasthan	1.4	5.6	-75	21.7	4.9	344	23.1	10.5	120
19.	West Madhya Pradesh	1.7	8.5	-80	31.1	5.1	509	32.8	13.6	141
20.	East Madhya Pradesh	2.0	20.0	-90	43.4	15.3	183	45.4	35.3	29
21.	Gujarat region	0.0	0.8	-100	1.1	0.3	250	1.1	1.1	-4
22.	Saurashtra & Kutch	1.9	0.4	367	0.2	0.2	15	2.1	0.6	250
23.	Konkan & Goa	0.0	0.1	-100	4.7	0.2	2249	4.7	0.3	1466
24.	Madhya Maharashtra	0.1	1.1	-93	5.3	0.8	558	5.3	1.9	181
25.	Marathawada	1.5	3.8	-60	9.4	3.0	213	10.9	6.8	60
26.	Vidarbha	6.6	10.2	-35	13.0	7.0	85	19.6	17.2	14
27.	Chattisgarh	2.9	10.7	-73	19.4	10.6	83	22.3	21.3	5
28.	Coastal Andhra Pradesh	1.2	8.3	-85	38.2	10.4	268	39.5	18.7	111
29.	Telangana	3.9	5.8	-32	30.2	5.5	449	34.1	11.3	202
30.	Rayalaseema	0.7	3.0	-77	21.5	3.6	497	22.2	6.6	236
31.	Tamil Nadu	3.9	17.5	-78	30.9	13.4	130	34.8	30.9	13
32.	Coastal Karnataka	3.5	0.7	397	15.8	0.2	7806	19.3	0.9	2043
33.	North interior Karnataka	1.2	2.2	-45	6.1	1.7	259	7.3	3.9	87
34.	South interior Karnataka	0.5	1.4	-65	10.1	3.0	237	10.6	4.4	141
35.	Kerala	3.9	8.7	-56	40.1	14.7	173	43.9	23.4	88
36.	Lakshadweep	26.2	20.8	26	34.4	14.7	134	60.6	35.5	71

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

TABLE 2

Details of the weather systems during January 2013

S. No.	System	Duration	Place of first location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Low pressure area*					
1.	Low pressure area	7 - 8	Equatorial Indian Ocean and adjoining southwest Bay of Bengal	West	Sri Lanka and adjoining Comorin area	It was seen as a trough of low at mean sea level from 31 December 2012 – 6 January 2013 over southeast Bay of Bengal and equatorial Indian Ocean. Associated cyclonic circulation extended upto mid tropospheric levels. A trough of low at mean sea level lay over Comorin area and neighbourhood with a cyclonic circulation aloft extending upto 2.1 kms a.s.l. on 9. It became unimportant on 13
(**B**)	*Western disturbances / eastward moving systems*					
(*i*)	*Upper air cyclonic circulations*					
1.	Up to 4.5 kms a.s.l.	2 - 4	North Pakistan and neighbourhood	Northeast	Jammu & Kashmir and neighbourhood	Moved away on 5
2.	Do	6 - 10	Northeast Afghanistan and neighbourhood	Do	Eastern parts of Jammu & Kashmir	Moved away on 10 evening
3.	Do	9 - 13	Do	Do	Do	Moved away on 14
4.	Do	13 - 19	Do	Do	Do	Moved away on 19 evening
5.	Do	21 – 24	Northern parts of Afghanistan and neighbourhood	Do	Do	Moved away on 24 evening
6.	Do	25 - 28	Northeast Afghanistan and adjoining north Pakistan	Do	Jammu & Kashmir and neighbourhood	Moved away on 29
7.	Upper air	29 Jan - 1 Feb	Northeast Afghanistan and adjoining Pakistan	Do	North Pakistan and adjoining Jammu & Kashmir	Moved away on 2 February
(*ii*)	*Induced systems*					
1.	Low pressure area	18 - 19	Central parts of Rajasthan and neighbourhood.	Stationary	*In situ*	First it was seen as an induced cyclonic circulation over west Rajasthan and neighbourhood on 16 & 17 and as an induced low pressure area on 18. Associated cyclonic circulation extending upto 4.5 kms a.s.l. also became less marked on 19

TABLE 2 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(*iii*)	*Trough in westerlies*					
1.	Upto Mid & Upper tropospheric level	16 - 19	Long. 62° E, to the north of Lat. 20° N at 5.8 kms a.s.l.	Northeast	Long. 80° E, to the north of Lat. 35° N	Moved away on 19 evening
2 .	Upper tropospheric level	23 - 24	Long. 74° E, to the north of Lat. 30° N at 7.6 kms a.s.l.	Do	Long. 80° E, to the north of Lat. 30° N	Moved away on 24 evening
(**C**)	*Other cyclonic circulations*					
1.	Upto 0.9 km a.s.l.	1 – 2	Vidarbha and adjoining south Madhya Pradesh	East	East Madhya Pradesh and adjoining Chhattisgarh	Less marked on 3
2.	Do	3 - 4	Nagaland-Manipur-Mizoram-Tripura and neighbourhood	Stationary	*In situ*	Less marked on 5
3.	Do	7	Chhattisgarh and adjoining Odisha	Do	Do	Less marked on 8
4.	Upto 1.5 kms a.s.l.	7	Assam & Meghalaya and neighbourhood	Do	Do	Less marked on 8
5.	Upto mid tropospheric levels	20 - 21	Do	Do	Do	Less marked on 22
6.	Upto 1.5 kms a.s.l.	23 - 25	Lakshadweep area and neighbourhood	Do	Do	Less marked on 26
7.	Upto 2.1 kms a.s.l.	24 - 26	North Madhya Maharashtra and neighbourhood	Do	Do	Less marked on 27
8.	Upto mid tropospheric levels	25 - 30	Assam & Meghalaya and neighbourhood	East	Assam & Meghalaya and adjoining Nagaland-Manipur-Mizoram-Tripura	Less marked on 31
9.	Upto 3.1 kms a.s.l.	30 Jan - 1 Feb	Sumatra coast and adjoining south Andaman Sea	Do	Do	Less marked on 2 February
(**D**)	*Trough in easterlies*					
1.	Trough of low (mean sea level)	19 - 20	Southwest Bay of Bengal and adjoining equatorial Indian Ocean	West	Southwest Bay of Bengal off Sri Lanka coast	A cyclonic circulation extending upto 0.9 km a.s.l. lay embedded on 19. It became less marked on 21
2.	Do	20 - 25	South Andaman Sea and neighbourhood	Do	Southwest Bay of Bengal and neighbourhood	Less marked on 26
3.	Do	26 - 29	Andaman Sea and adjoining southeast Bay of Bengal	Do	Southeast Bay of Bengal and neighbourhood	Became unimportant on 30

WDs did not remain confined to the extreme northern parts of India during this season. There had been interaction of troughs in the mid-latitude westerlies with the tropical easterlies, causing precipitation over major parts of the country. This resulted in *excess* rainfall situation over most parts of the country, by the end of the season. The easterly-westerly interaction occurred from the second fortnight of January led to the above normal rainfall activity all over the country, outside east and northeast India.

3. Monthly features

3.1. *January*

3.1.1. *Weather and associated synoptic features*

As given in Table 2, 10 WDs (including 1 induced low pressure area, 7 upper air cyclonic circulations and 2 troughs in westerlies), 1 low pressure area, 9 other cyclonic circulations and 3 troughs in easterlies formed which affected the weather over the country during the month of January.

3.1.2. *Monthly rainfall*

The sub-divisionwise percentage departures of monthly rainfall are given in Table 1. Out of the 36 met-subdivisions of India, the month's rainfall was *excess* in 6, *normal* in 2, *deficient* in 6 and *scanty* in 20 sub-divisions. No rainfall was reported in the remaining 2 met. sub-divisions *viz*., Gujarat region and Konkan & Goa.

The WDs and their induced low pressure systems remained dry during the first fortnight of January in the presence of a large scale continental anticyclone over the northern plains in the lower troposphere. However, the beginning of the second fortnight witnessed widespread precipitation in the form of heavy snowfall, thunderstorms and hailstorms over northwest India. This had resulted from the superposition of the upper level divergence field ahead of a trough in the mid-latitude westerlies over an active WD. Subsequent to the passage of this WD, dense to moderate fog prevailed in parts of Punjab, Haryana, Chandigarh & Delhi and north Rajasthan.

The systems in westerlies during the third week and interaction of troughs in westerlies and easterlies gave precipitation over parts of north, central and northeast India, during the last week of the month.

3.1.3. *Temperature*

Severe cold wave/cold wave/cold day conditions prevailed on most of the days over east Uttar Pradesh and Madhya Pradesh and on a few days over the remaining parts of the country outside Konkan & Goa, Marathawada and south Peninsular India.

Minimum temperatures were *markedly/appreciably below normal* over major parts of the country during the first week except over south Peninsular India. This trend continued in the second week, but was restricted to northeast and some parts of east India. During the second week and after the cessation of northeast monsoon, *below normal* minimum temperatures were observed over parts of south Peninsular India whereas, *above/appreciably above* normal temperatures were observed over the north and central India. The temperatures started to dip from the later part of the third week except over south Peninsular India where it was normal. During the last week, *below/appreciably below* normal temperatures were observed over east & northeast India, and some parts of central and north India.

During the first week of the month, large scale subsidence prevailed over the northern plains resulting in a stable inversion layer, thereby trapping cold and dry air in the lower troposphere which led to persistent dense fog. Hence during this period, the maximum temperatures were also *markedly* to *appreciably below normal* over many parts of the country during the first week except over south Peninsular India. The temperatures were *appreciably above or above normal* over many parts of the country during the second week. It remained *appreciably above/above normal* over many parts of the country outside parts of north and central India during third week and parts of east and central India during the fourth week.

The maximum temperatures were about 5-10 °C below normal in the first week of January 2013. On 6th January, minimum temperatures were below 0°C at places like Hissar (-1.5°C), Karnal (-0.2°C), Panipat (-0.2°C), Rewari (-1.0°C) and Bhiwani (-1.5°C) in Haryana. Churu reported -2.2°C and Sikar -3.8°C in Rajasthan on 6th January 2013.

Analogous to December-2012, Kashmir valley continued to reel under extreme cold. Many places *viz*.; Leh (minus 20.0° C, on 23rd), Keylong (minus 12.5° C on 19th) and Gulmarg (minus 9.0° C, on 6th) reported sub-zero temperatures.

The last time, north India experienced similar persistent *cold wave condition* in 1973. The presence of low level anticyclone had caused persistent fog, leading too much below normal day temperatures during the first fortnight of January.

TABLE 3

Details of the weather systems during February 2013

S. No.	System	Duration	Place of first location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Western disturbances / eastward moving systems*					
(*i*)	*Depression*					
1.	Western depression	5 - 6	Central Pakistan and adjoining Punjab and northwest Rajasthan	West	Northwest Rajasthan and neighbourhood	A low pressure was induced by western disturbance over central Pakistan and neighbourhood on 4 concentrated into a western depression on 5 morning and lay as low pressure area on 5 evening. It became less marked on 6 evening. Associated cyclonic circulation extended upto mid tropospheric levels
(*ii*)	*Upper air cyclonic circulations*					
1.	Up to 4.5 kms a.s.l.	2 - 7	Northeast Afghanistan and adjoining Pakistan	Northeast	Eastern parts of Jammu & Kashmir	Moved away on 7 evening
2.	Do (Feeble)	11 - 13	Jammu & Kashmir and neighbourhood	Do	Do	Moved away on 14
3.	Do	12 - 17	Northeast Afghanistan and neighbourhood	Do	Do	Moved away on 18
4.	Do	18 - 24	Afghanistan and neighbourhood	Do	Do	Moved away on 25
5	Upto 4.5 kms a.s.l.	25 - 28	Northeast Afghanistan and neighbourhood	Do	Do	Moved away on 1 March
(*iii*)	*Troughs in westerlies*					
1.	Upto Mid tropospheric level	4 - 8	Long. 64^{o} E, to the north of Lat. 18^{o} N at 5.8 kms a.s.l.	East-northeast	Long. 85^{o} E, to the north of Lat. 25^{o} N	Moved away on 9
2.	Do	15 - 17	Long. 65^{o} E, to the north of Lat. 18^{o} N at 5.8 kms a.s.l.	Do	Long. 78^{o} E, to the north of Lat. 18^{o} N	Moved away on 18
3.	Upto Lower levels	20	Assam & Meghalaya to north Bay of Bengal	Stationary	*In situ*	Less marked on 21
4.	Upto Mid-Upper tropospheric levels	22 - 24	Long. 65^{o} E, to the north of Lat. 25^{o} N at 5.8 kms a.s.l.	Northeast	Long. 82^{o} E, to the north of Lat. 18^{o} N	Moved away on 25
5.	Do	26 - 27	Long. 62^{o} E, to the north of Lat. 25^{o} N at 5.8 kms a.s.l.	East-northeast	Long. 66^{o} E, to the north of Lat. 25^{o} N at 5.8 kms a.s.l.	Moved away on 28

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(*iv*)	*Induced systems*					
(a)	*As low pressure area*					
1.	Low pressure area	16	Northern parts of Rajasthan and neighbourhood	Stationary	*In situ*	First seen as an induced cyclonic circulation extending upto mid tropospheric levels over central Pakistan and adjoining west Rajasthan on 14 evening. It lay over south Rajasthan and neighbourhood embedded in the trough from west coast to south Rajasthan on 15. The low pressure area became less marked on 17. Associated cyclonic circulation extending upto 3.6 kms a.s.l. lay over Haryana & neighbourhood on 17 and moved away northeastwards on 18
2.	Low pressure area	21 eve - 22 eve	Central Pakistan and adjoining west Rajasthan	Do	Do	Associated cyclonic circulation lay over northern parts of Rajasthan and adjoining Haryana on 23. Moving in east northeastward direction it became less marked on 26
(b)	*As cyclonic circulations*					
1.	Upto 3.6 kms a.s.l.	27	West Rajasthan and neighbourhood	Do	Do	Less marked on 28
(**B**)	*Other cyclonic circulations*					
1.	Between 0.9 km- 2.1 kms a.s.l..	1 - 3	South Rajasthan & neighbourhood	West	Southwest Rajasthan and neighbourhood	Less marked on 4
2.	Upto 1.5 kms a.s.l.	8 - 10	Assam & Meghalaya and neighbourhood	East	Nagaland-Manipur-Mizoram-Tripura	Less marked on 10 evening
3.	Upto 2.1 kms a.s.l.	13 - 14	Do	Stationary	*In situ*	Less marked on 15
4.	Upto 1.5 kms a.s.l.	18	Tripura and neighbourhood	Do	Do	Less marked on 19
5.	Upto 0.9 km a.s.l.	24	Chhattisgarh and adjoining Odisha	Do	Do	Less marked on 25
(**C**)	*Troughs in easterlies*					
1.	At mean sea level	6 - 18	Southeast and adjoining southwest Bay of Bengal	West	Southeast Arabian Sea	Became unimportant on 19
2.	Do	7 - 12	Southeast Bay of Bengal and adjoining south Andaman Sea	Do	Southwest Bay of Bengal off Sri Lanka coast	It merged with the trough of low at mean sea level from Comorin – Maldives areas to north Maharashtra coast on 13
3.	Do	19 - 21	Lakshadweep area and neighbourhood	Oscillatory	South Maharashtra coast to south Gujarat coast	Less marked on 22
4.	Do	25 Feb - 9 Mar	South Andaman Sea and neighbourhood	West	Lakshadweep area to east central Arabian Sea	Moved away on 10 Mar. Two cyclonic circulation aloft extended upto 0.9 km a.s.l. on 5 & 6 over Sri Lanka and adjoining areas of Gulf of Mannar and over Lakshadweep area to east central Arabian Sea on 8 & 9

Some stations of central and northeastern states, which recorded the lowest minimum temperature of the month by breaking the previous records are:

Station name	*Previous record (°C)*	*Date*	*New record (°C)*	*Date (Jan 13)*
Agartala	3.5	31 Jan 1964	3.3	10
Jalpaiguri	4.0	30 Jan 1964	4.0	9
Gaya	1.5	08 Jan 2000	1.4	9
Muzzafarpur	2.7	20 Jan 1908	2.5	9
Bareilly	0.6	24 Jan 1989	-0.1	9
Patna	1.4	21 Jan 1984	1.1	9
Gorakhpur	1.7	15 Jan 1933	-1.0	9
Satna	0.6	16 Jan 1933	0.4	7

(*Source* : CDBI January, 2013)

The month's and the season's lowest minimum temperature over the plains of the country was minus 3.8° C recorded at Sikar (east Rajasthan) on 6th January 2013.

3.1.4. *Disastrous weather events and damage*

Heavy snowfall and avalanche in the western Himalayan region claimed 7 lives in Himachal Pradesh and 2 in Kashmir valley. Due to heavy rain / snow, the Jammu-Srinagar National Highway was closed for a few days. *Cold wave/severe cold wave* claimed 175 lives in Uttar Pradesh, 15 in Uttarakhand, 9 in Punjab, 4 in Haryana, 2 in Rajasthan and 1 in Jammu & Kashmir. Poor visibility and thick fog affected normal life and air/train services in north India. It also adversely affected Rabi crops in Uttar Pradesh and Madhya Pradesh. Severe Hailstorm claimed 9 lives in Ranga Reddy district of Andhra Pradesh. Lightning claimed 3 lives in Uttar Pradesh.

3.2. *February*

3.2.1. *Storms and depressions*

No intense low pressure system formed over the Indian seas during the month.

3.2.2. *Other synoptic features and associated weather*

As given in Table 3, 1 low pressure area, 14 WDs (including 1 Western Depression, 2 induced low pressure areas, 5 upper air cyclonic circulations, 1 induced cyclonic circulation and 5 troughs in westerlies), 5 upper air cyclonic circulations and 4 troughs in the easterlies formed which affected the weather over the country during the month of February.

Northwest India was affected by two WDs in succession, during the initial part of the month itself. The first one was an upper air cyclonic circulation, which remained feeble and the realized weather was mainly confined to the higher reaches of the Himalayas. It was low pressure area induced by the second system, which subsequently concentrated into a 'Western Depression' and caused widespread severe weather over the northwestern parts of the country. The intensification of the low pressure area could be attributed to the favourable super-positioning of the upper level divergence field associated with a deep trough in the mid & upper tropospheric westerlies to the rear of the system. The pressure departure field associated with the depression had been of the order of minus 10 hPa on 5th. There had been 3 closed isobars at 2 hPa interval on the mean sea level chart to categorise the system as a western depression on 5th February.

Apart from this, the later part of the month also experienced precipitation all over the country on account of the passage of WDs and their in phase interactions with the low latitude easterlies.

3.2.3. *Monthly rainfall*

Out of the 36 met-subdivisions of India, the month's rainfall was *excess* in 28, normal in 2, *deficient* in 3 and *scanty* in 3 sub-divisions.

Due to the favourable interaction between synoptic systems in westerlies and high amplitude easterlies, most of the sub-divisions received excess precipitation except northeast India, West Bengal & Sikkim and Odisha.

Some of the stations of north and peninsular India recorded highest ever 24 hour rainfall for the month. Details are given below.

Station Name	*24 hr Rainfall record (mm) Previous*	*Date & Year*	*24 hr Rainfall record (mm) New Record*	*Date (Feb 13)*
Motihari	40.6	4 Feb 1956	50.8	17
Lucknow AP	46.7	1 Feb 1982	54.7	6
Muzaffarnagar	46.6	11 Feb 2000	58.6	5
Pant Nagar	16.4	5 Feb 1972	52.8	17
Shimla	63.5	2 Feb 1908	75.6	6
Barmer	23.6	28 Feb 1939	25.0	16
Pilani	39.2	28 Feb 1990	46.6	17
Vijaywada AP	60.0	22 Feb 2011	145.5	17
Karwar	25.9	3 Feb 1917	34.9	17
Panambur	6.9	6 Feb 1978	59.6	17
CIAL Kochi	3.5	10 Feb 2008	48.6	19

(*Source* : CDBI February 2013)

3.2.4. *Temperature*

February, being a transition period from winter to summer, the weather over most parts of the country is normally very comfortable. This year, due to the presence of conducive conditions for moisture incursion, *cold wave/severe cold wave* were observed only on one or two days at isolated places during the month.

Severe cold wave conditions prevailed on 1 day each in some parts of Vidarbha and south interior Karnataka. *Cold wave conditions* prevailed on 1 to 3 days in some parts of Odisha, Jammu & Kashmir, Madhya Pradesh and south interior Karnataka. *Cold day conditions* prevailed on 1 day each in Uttar Pradesh, Haryana and Punjab.

Minimum temperatures were *appreciably above/above normal* during the first fortnight over many parts of the country and *appreciably below/below normal* during the second fortnight over some parts of east, central and southern India.

Maximum temperatures were *appreciably below/below normal* during the third week over many parts of the country and on a few days during the first and the third week over north India. They were generally *appreciably above/above normal* on the remaining days of the month.

Some of the stations which recorded highest ever maximum temperatures for the month are:

Station name	*Previous record (°C)*	*Date*	*New record (°C)*	*Date (Feb '13)*
Dibrugarh AP	31.9	12 Feb 1999	33.2	23, 24
Imphal	31.5	19 Feb 2009	32.0	24
Passighat	31.5	28 Feb 1975	33.2	24
Cooch Behar	31.8	26 Feb 2011	32.5	23

(*Source* : CDBI February 2013)

During the month, the lowest minimum temperature recorded over the plains of the country was 3.6° C recorded at Amritsar (Punjab) on 9th February.

3.2.5. *Disastrous weather events and damage*

According to press and media reports, cold wave claimed 26 lives in Uttar Pradesh and 2 in Jammu & Kashmir. Avalanche/landslide claimed 7 lives in Himachal Pradesh and 2 in Uttarakhand. Floods and heavy rain claimed 31 lives in Uttarakhand and 22 in Andhra Pradesh and 51 reported missing in Uttarakhand. Thunderstorm/ Lightning/ Hailstorm claimed 10 lives in Uttar Pradesh, 8 in Madhya Pradesh and 3 each Punjab & Rajasthan and 1 in Tamil Nadu.

Rain and hailstorm damaged standing crops in Rajasthan, Madhya Pradesh, Maharashtra and Andhra Pradesh. Hundreds of vehicles remained stranded on Jammu-Srinagar National Highway due to rain and snowfall.

Appendix

Definitions of the terms given in '*Italics*'

Rainfall

Excess - percentage departure from normal is + 20 % or more.

Normal - percentage departure from normal is –19 % to +19 %.

Deficient - percentage departure from normal is –20 % to –59 %.

Scanty - percentage departure from normal is –60 % to –99 %.

Temperatures

As per the revised criteria for declaring cold wave, the actual minimum temperature of a station is reduced to 'Wind Chill Effective minimum temperature' (WCTn) based on the wind chill factor using the table given in WMO No. 331/ Technical Note No. 123. For declaring cold wave etc. WCTn only is used and when it is $\leq$ 10 °C only, cold wave is considered (this criteria does not hold for coastal stations).

Severe cold wave conditions - departure of WCT_n from normal minimum temperature is –7 °C or less for the regions where normal minimum temperature is $\geq$ 10 °C and –6 °C or less elsewhere.

Cold wave conditions - departure of WCTn from normal minimum temperature is from –5 °C to –6 °C where normal minimum temperature $\geq$ 10° C and from –4 °C to –5 °C elsewhere.

Also cold wave is declared when WCTn is $\leq$ 0 °C irrespective of the normal minimum temperature for those stations.

Cold day conditions maximum day temperature is less than 16 °C over the plains.

Markedly below normal - departure of minimum temperature from normal is from –5 °C to –6 °C for the region where the

normal minimum temperature is 10 °C or more and from –3 °C to –4 °C elsewhere.

Appreciably below normal - departure of minimum temperature from normal is from –3 °C to –4 °C for the region where the normal minimum temperature is 10 °C or more.

Markedly above normal - departure of minimum temperature from normal is from + 5 °C to + 6 °C.

Appreciably above normal - departure of minimum temperature from normal is from +3 °C to +4 °C.

Above normal - departure of minimum temperature from normal is + 2 °C.