

## Weather in India

### MONSOON SEASON (JUNE - SEPTEMBER 2016)†

#### 1. Introduction

The seasonal rainfall (during June to September 2016) over the country as a whole was 97% of its Long Period Average (LPA) and thus categorized as a normal monsoon characterized by pronounced spatial and temporal variability. The pace of advance of southwest monsoon over mainland was sluggish this year. With the weakening of Southern Hemispherical Equatorial Trough (SHET) towards the end of first week of June, the cross equatorial flow strengthened and the southwesterlies also deepened which led to increase in rainfall activity over Kerala. This aided in the setting in of southwest monsoon over Kerala. With the formation of an east-west shear zone at mid tropospheric level during the second week of July led to further advance over the entire country on 13<sup>th</sup> July. Except for July month, the rainfall remained below normal for the rest of the months. In all 14 low pressure areas formed during the monsoon season this year, out of which four intensified into depressions as against the normal frequency of 4-6 monsoon Depressions during the season.

#### 2. Various aspects of southwest Monsoon– 2016

##### 2.1. Onset and Advance

Fig. 1 shows the isochrones of advance of monsoon over the country. Table 1 gives the details of day-to-day advance taken place.

Genesis phase of the Cyclonic Storm ‘Roanu’ created the synoptic situation conducive for the advent of southwest monsoon current into parts of south Bay of Bengal, Nicobar Islands and adjoining Andaman Sea on 18<sup>th</sup> May, 2 days ahead of its normal date. It further advanced into some more parts of southeast Bay of Bengal, remaining parts of Andaman Sea and Andaman Islands on 20<sup>th</sup> May.

The southwest monsoon set in over Kerala on 8<sup>th</sup> June, 7 days after its normal date. On this day, it advanced into south Arabian Sea, Maldives-Comorin area, most parts of Kerala and Tamil Nadu, some parts of south

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

†Compiled by :Sunitha Devi S. and A. P. Kundale and P.N. Chopade, Meteorological Office, Pune – 411 005, India

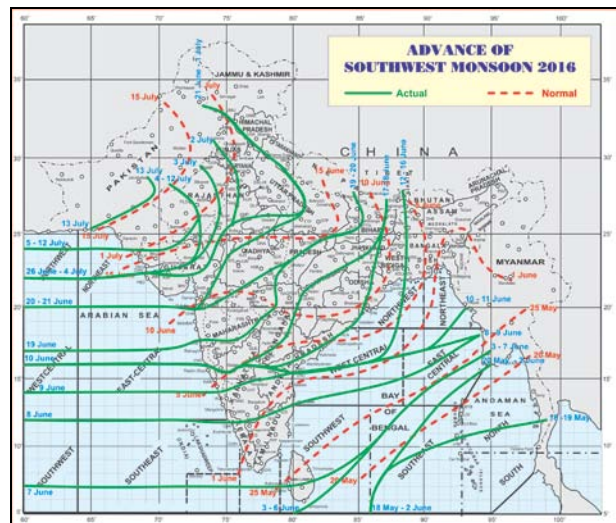
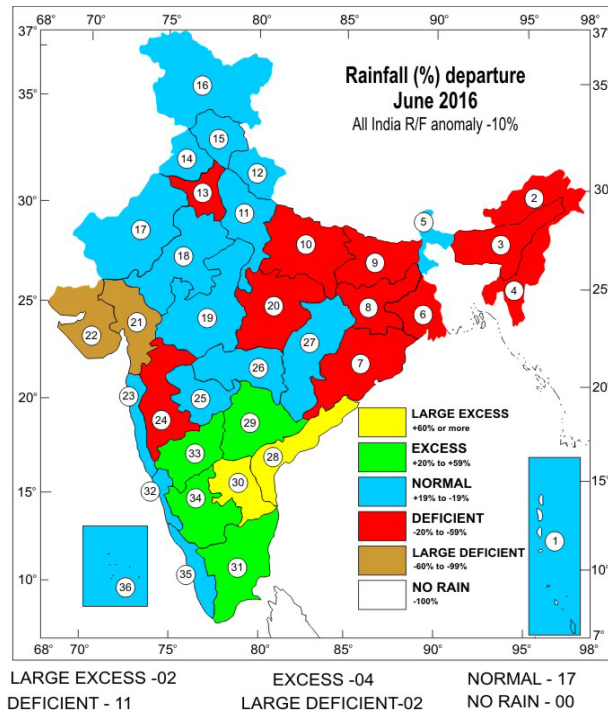


Fig.1. Isochrones of advance of SW monsoon 2016

interior Karnataka, remaining parts of south Bay of Bengal and some more parts of central Bay of Bengal.

Then, it rapidly advance upto Lat. 15° N in the subsequent two days. Thereafter a hiatus occurred on western part due to weakening of the Arabian Sea branch. A comparatively stronger Bay of Bengal branch led to further advance of monsoon into northeastern states by 14<sup>th</sup> June. In the third week, as the convectively active phase of the Madden Julian Oscillation (MJO) moved eastwards over the Indian Seas, the Bay of Bengal became more convectively active. Triggered by this, the southwest monsoon advanced rapidly further and covered most parts of peninsular India and western Himalayan region, entire central and east India and some parts of north Arabian Sea and northwest India by 22<sup>nd</sup> June. The last week of June, witnessed the formation of a Depression over northeast Arabian Sea and a low pressure area over west central and adjoining northwest Bay of Bengal. Aided with active east-west trough and shear zone embedded with circulations enhanced the rainfall activity over northern plains and central India. But it did not help much in the further advance of monsoon. Thus, a hiatus re-occurred during the last week of June. With the strengthening of wind in the lower tropospheric levels in the first week of July and the formation of a short-lived Land Depression led to rapid advance of southwest monsoon to cover most



**Fig. 2.** Rainfall for the month of June 2016 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

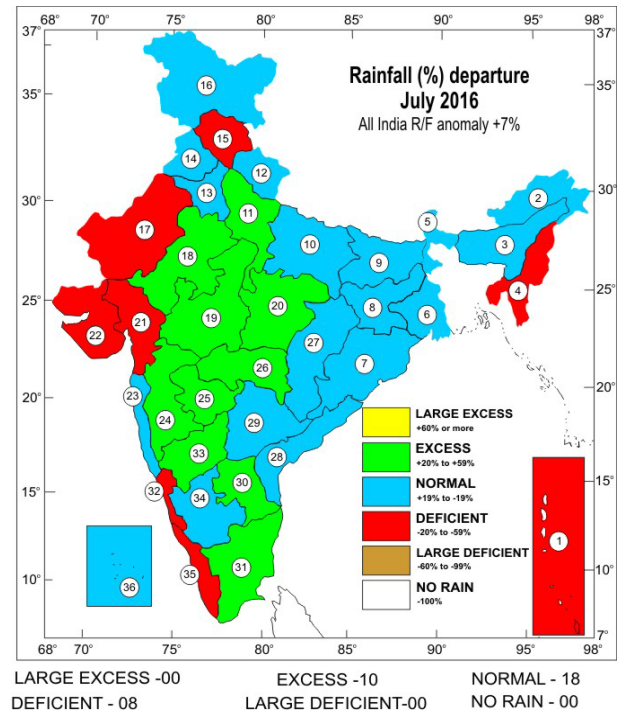
<b>1</b> -2	<b>7</b> -23	<b>13</b> -22	<b>19</b> 5	<b>25</b> 10	<b>31</b> 37
<b>2</b> -24	<b>8</b> -38	<b>14</b> 18	<b>20</b> -26	<b>26</b> -2	<b>32</b> 11
<b>3</b> -27	<b>9</b> -24	<b>15</b> 6	<b>21</b> -76	<b>27</b> -12	<b>33</b> 31
<b>4</b> -30	<b>10</b> -28	<b>16</b> -2	<b>22</b> -64	<b>28</b> 82	<b>34</b> 22
<b>5</b> 18	<b>11</b> -16	<b>17</b> 11	<b>23</b> 16	<b>29</b> 43	<b>35</b> -8
<b>6</b> -29	<b>12</b> 4	<b>18</b> -1	<b>24</b> -31	<b>30</b> 90	<b>36</b> -3

parts of the country, outside some areas of Kutch and west Rajasthan by 5<sup>th</sup> July. Reduced rainfall activity thereafter in the regions where monsoon was yet to advance resulted once again a hiatus for a week. The formation of an east-west shear zone at mid tropospheric levels and its northward shifting to the north of Lat. 20° N helped the SW monsoon to cover the entire country on 13<sup>th</sup> July.

### 2.2. Monthly rainfall distribution

Figs. 2-5 show the month-wise spatial distribution of rainfall. The monthwise and seasonal rainfall statistics is provided in Table 2.

In June, 2 sub-divisions received *Large excess* (coastal Andhra Pradesh and Rayalaseema) and 4 sub-divisions received *excess* rainfall, 17 received *normal* rainfall, 2 sub-divisions (Gujarat Region & Saurashtra &



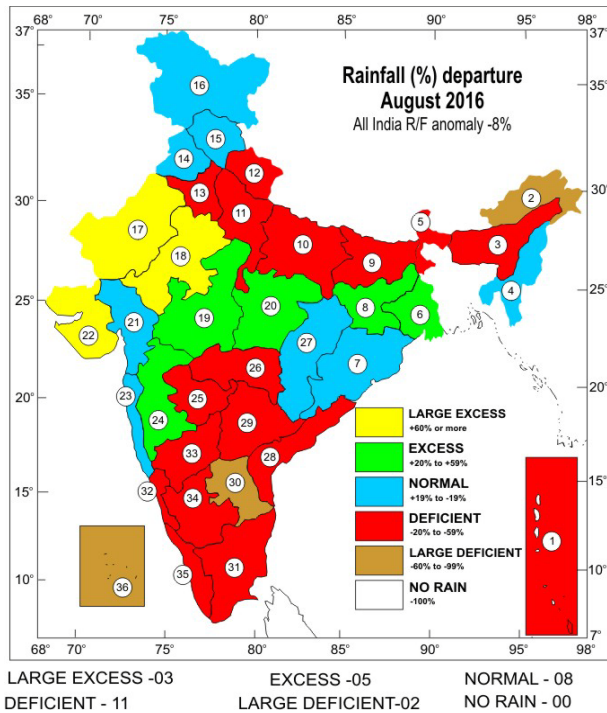
**Fig. 3.** Rainfall for the month of July 2016 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

<b>1</b> -26	<b>7</b> -17	<b>13</b> -4	<b>19</b> 48	<b>25</b> 47	<b>31</b> 28
<b>2</b> 16	<b>8</b> -10	<b>14</b> -18	<b>20</b> 59	<b>26</b> 57	<b>32</b> -34
<b>3</b> -10	<b>9</b> 4	<b>15</b> -37	<b>21</b> -25	<b>27</b> -4	<b>33</b> 20
<b>4</b> -21	<b>10</b> 13	<b>16</b> 0	<b>22</b> -42	<b>28</b> -18	<b>34</b> -9
<b>5</b> 19	<b>11</b> 37	<b>17</b> -22	<b>23</b> 19	<b>29</b> -1	<b>35</b> -39
<b>6</b> 1	<b>12</b> 19	<b>18</b> 45	<b>24</b> 32	<b>30</b> 39	<b>36</b> -9

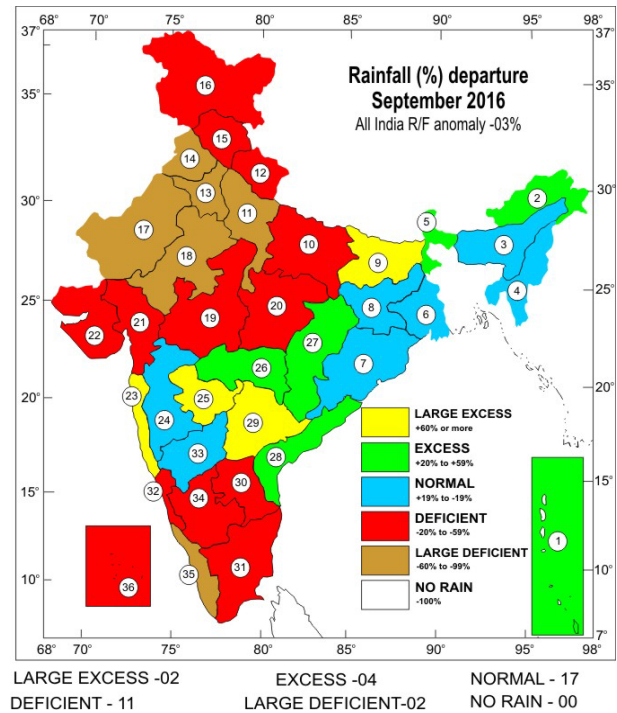
Kutch) received *Large deficient* rainfall and 11 subdivisions received *deficient* rainfall.

In July, the north-south belt comprising of the States and Meteorological subdivisions such as west Uttar Pradesh, Madhya Pradesh, east Rajasthan, Madhya Maharashtra, Marathwada, Vidarbha, north interior Karnataka, Rayalaseema and Tamil Nadu received *widespread* and *excess* rainfall. Out of 36 meteorological subdivisions, 10 received *excess* rainfall, 18 received *normal* rainfall and the remaining 8 subdivisions received *deficient* rainfall.

In August, rainfall activity over the country as a whole was near *normal*. Out of 36 meteorological subdivisions, 3 received *Large excess* (East Rajasthan, West Rajasthan and Saurashtra & Kutch), 5 received *excess* rainfall, 8 received *normal* rainfall, 17 received *deficient*



**Fig. 4.** Rainfall for the month of August 2016 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :



**Fig. 5.** Rainfall for the month of September 2016 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

rainfall & 3 subdivisions received *Large deficient* rainfall (Arunachal Pradesh, Rayalaseema and Lakshadweep)

In September, rainfall activity over the country as a whole was normal. Meteorological subdivisions of Central, eastern/northeastern & north peninsular India and the Andaman & Nicobar Islands received *excess/normal* rainfall, whereas rest of the country received *deficient* rainfall. Out of 36 meteorological subdivisions, 4 received *Large excess* and 6 received *excess* rainfall, 7 received normal rainfall, 13 received *deficient* rainfall and the remaining 6 subdivisions received *Large deficient* rainfall.

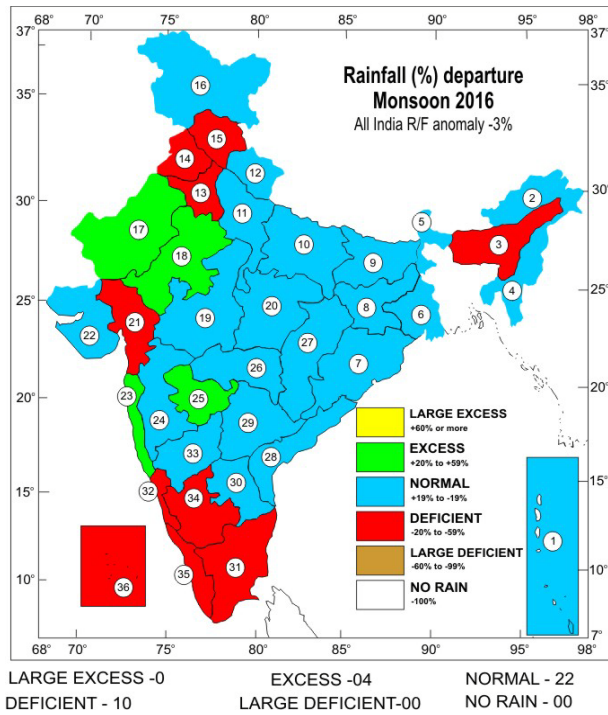
From the monthly distribution, it can be seen that except Konkan & Goa and Chhattisgarh all the other subdivisions received *deficient/ Large deficient* monthly rainfall during at least one of the four months. During the month of August and September, all sub - divisions of

south Peninsular India and of northwest India received deficient/Large deficient rainfall respectively whereas Saurashtra & Kutch received *large excess* rainfall during August and *deficient* rainfall during rest of the 3 months.

### 2.3. Seasonal rainfall distribution

Meteorological sub-division wise seasonal rainfall distribution in terms of percentage departures from *normal* is given in Fig. 6. Out of the total 36 meteorological subdivisions, the season rainfall was *normal* in 22 subdivisions and *deficient* in 10 subdivisions. Four sub-division viz., west Rajasthan, east Rajasthan, Konkan & Goa and Marathwada received *excess* rainfall and no Sub-divisions reported *Large excess* and *Large Deficient* rainfall by the end of the season. Out of the 10 *deficient* subdivisions, 5 subdivisions were from south Peninsular





**Fig. 6.** Rainfall for the month of monsoon 2016 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

<b>1</b> -7	<b>7</b> -10	<b>13</b> -26	<b>19</b> 19	<b>25</b> 21	<b>31</b> -20
<b>2</b> -5	<b>8</b> 1	<b>14</b> -25	<b>20</b> 19	<b>26</b> 10	<b>32</b> -21
<b>3</b> -26	<b>9</b> -3	<b>15</b> -24	<b>21</b> -24	<b>27</b> 2	<b>33</b> 4
<b>4</b> -18	<b>10</b> -12	<b>16</b> -10	<b>22</b> -13	<b>28</b> 15	<b>34</b> -22
<b>5</b> 0	<b>11</b> -17	<b>17</b> 20	<b>23</b> 22	<b>29</b> 19	<b>35</b> -34
<b>6</b> -1	<b>12</b> -10	<b>18</b> 32	<b>24</b> 13	<b>30</b> -2	<b>36</b> -25

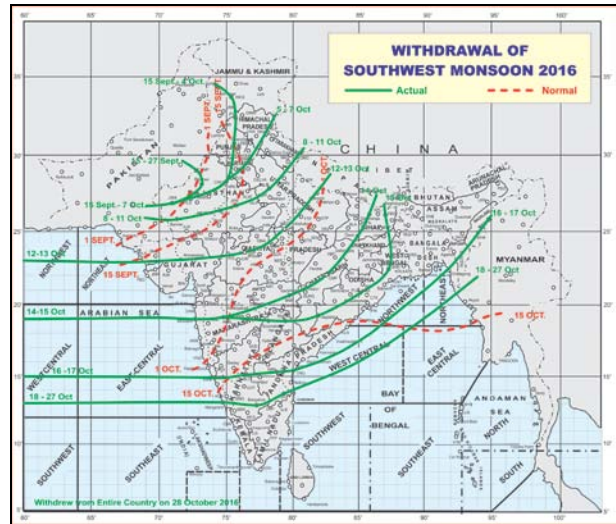
India, 3 from north India, 1 from northeast India and 1 from central India.

Table 4 contains the representative amounts of very heavy and extremely heavy rainfall observed during the season.

#### 2.4. Withdrawal of southwest monsoon

Fig. 7 shows the isochrones of withdrawal of SW Monsoon. Table 3 contains the details of day-to-day withdrawal taken place.

The rainfall activity over the northwestern parts of Rajasthan remained subdued since 5<sup>th</sup> September. A change over in the lower tropospheric circulation pattern over the region from cyclonic to anti cyclonic on 15<sup>th</sup> September indicated the beginning of the withdrawal of southwest monsoon from the region.



**Fig. 7.** Isochrones of withdrawal of southwest monsoon 2016

Subsequent to the commencement of withdrawal of southwest monsoon from western parts of Rajasthan on 15<sup>th</sup> September, moisture incursion due to the low level south-easterlies resulted in isolated convective rainfall events over major parts of northwest India. Though west Rajasthan reported “Dry weather” upto 22<sup>nd</sup> September, isolated rainfall activity re-commenced over this met. Sub-division from 23<sup>rd</sup> - 28<sup>th</sup>. Similarly the other three western most sub-divisions over north India, viz., Jammu & Kashmir, Punjab and Haryana, Chandigarh & Delhi experienced isolated rainfall on most of the days from 16<sup>th</sup>-28<sup>th</sup> Sept. However, on 28<sup>th</sup> September, the lower tropospheric flow pattern and INSAT -3D derived total perceptible water vapour indicated a further reduction in the humidity levels over these regions, which implied the occurrence of dry weather during the coming 3-4 days over parts of these sub-divisions. These features suggested that the southwest monsoon further withdrew from parts of the above mentioned regions on 28<sup>th</sup>.

With the southward shift of the Sub-tropical westerly Jet stream over to the northern most Indian Latitudes since first week of October led to the cutoff of moisture thereby causing further withdrew of southwest monsoon from some more parts of northwest India on 5<sup>th</sup> October. With the increase in dominance of mid-latitude circulation regime over the northern half of India caused reduction in the lower tropospheric moisture and hence the rainfall led to further withdrew of southwest monsoon from most parts of northwest India and some parts of western and central India by 12<sup>th</sup> October and from major parts of India except parts of south peninsula by 18<sup>th</sup> October. The formation of a low pressure area over east central Bay of Bengal on 19<sup>th</sup> and its further intensification as a cyclonic

**TABLE 1**  
**Advance of southwest Monsoon 2016**

S. No.	Date	Southwest monsoon advanced over:	Northern Limit of Monsoon Passed through
1.	18 May	Some parts of southeast Bay of Bengal, entire south Andaman Sea and Nicobar Islands and some parts of north Andaman Sea	Lat. 5° N / Long. 86° E, Lat. 8° N / Long. 87° E, Hut Bay and Lat. 12° N / Long. 99° E
2.	20 May	Some more parts of southeast Bay of Bengal, remaining parts of Andaman Sea and Andaman Islands	Lat. 5° N / Long. 86° E, Lat. 8° N / Long. 87° E, Lat. 13° N / Long. 91° E and Lat. 16° N / Long. 95° E
3.	3 June	Some more parts of southeast Bay of Bengal and some parts of southwest and east central Bay of Bengal	Lat. 5° N / Long. 80° E, Lat. 11° N / Long. 87° E, Lat. 14° N / Long. 90° E and Lat. 17° N / Long. 95° E
4.	7 June	Some more parts of south Arabian Sea, Maldives-Comorin area and some more parts of southwest & southeast Bay of Bengal	Lat. 7° N / Long. 60° E, Lat. 7° N / Long. 70° E, Lat. 7° N / Long. 79° E, Lat. 11° N / Long. 87° E, Lat. 14° N / Long. 90° E, and Lat. 17° N / Long. 95° E
5.	8 June	Remaining parts of south Arabian Sea, Maldives-Comorin area, most parts of Kerala & Tamil Nadu, some parts of South Interior Karnataka, remaining parts of south Bay of Bengal and some more parts of central Bay of Bengal.	Lat. 12° N / Long. 60° E, Lat. 12° N / Long. 70° E, Kannur, Chennai, Lat. 14° N / Long. 84° E, Lat. 17° N / Long. 92° E and Lat. 18° N / Long. 94° E
6.	9 June	Some parts of central Arabian Sea, remaining parts of Kerala, Tamil Nadu, most parts of coastal Karnataka, some more parts of south interior Karnataka, some parts of Rayalaseema & coastal Andhra Pradesh & some more parts of central Bay of Bengal	Lat. 14° N / Long. 60° E, Lat. 14° N / Long. 70° E, Honavar, Anantapur, Ongole, Lat. 16° N / Long. 85° E, Lat. 17° N / Long. 90° E and Lat. 18° N / Long. 94° E
7.	10 June	Some more parts of central Arabian Sea, remaining parts of coastal & south interior Karnataka and some parts of north interior Karnataka, some more parts of Rayalaseema and south coastal Andhra Pradesh and east central Bay of Bengal and some parts of northeast Bay of Bengal	Lat. 15° N / Long. 60° E, Lat. 15° N / Long. 70° E, Karwar, Gadag, Ongole, Lat. 16° N / Long. 85° E, Lat. 17° N / Long. 90° E and Lat. 20° N / Long. 93° E
8.	14 June	Remaining parts of east central Bay of Bengal, some more parts of west central Bay of Bengal, some parts of northwest Bay of Bengal, entire northeast Bay of Bengal and northeastern states and some parts of Sub-Himalayan West Bengal & Sikkim	Lat. 15° N / Long. 60° E, Lat. 15° N / Long. 70° E, Karwar, Gadag, Ongole, Lat. 16° N / Long. 85° E, Lat. 20° N / Long. 90° E, Lat. 22° N / Long. 90° E and Gangtok
9.	17 June	Remaining parts of Rayalaseema and Bay of Bengal, most parts of coastal Andhra Pradesh and West Bengal & Sikkim and some parts of Odisha, Jharkhand and Bihar	Lat. 15° N / Long. 60° E, Lat. 15° N / Long. 70° E, Karwar, Gadag, Kurmool, Kalingapatnam, Cuttack, Jamshedpur and Forbesganj
10.	18 June	Remaining parts of Coastal Andhra Pradesh, Odisha and Gangetic West Bengal, some more parts of north interior Karnataka, some parts of Vidarbha, Chhattisgarh and Telangana and some more parts of Jharkhand and Bihar	Lat. 15° N / Long. 60° E, Lat. 15° N / Long. 70° E, Karwar, Gadag, Hanamkonda, Rajnandgaon, Ranchi and Forbesganj
11.	19 June	Some more parts of central Arabian Sea, entire Goa, some parts of south Konkan, Madhya Maharashtra, Marathwada, east Madhya Pradesh, southeast Uttar Pradesh, some more parts of Vidarbha, Bihar and remaining parts of north interior Karnataka, Telangana, Chhattisgarh and Jharkhand	Lat. 17° N / Long. 60° E, Lat. 17° N / Long. 70° E, Harnai, Sholapur, Nanded, Yeotmal, Chindwara, Siddhi, Patna and Raxaul
12.	20 June	Remaining parts of central Arabian Sea, Konkan (including Mumbai), Marathwada and Vidarbha, most parts of Madhya Maharashtra (including Pune), some parts of south west Madhya Pradesh and some more parts of east Madhya Pradesh	Lat. 20° N / Long. 60° E, Lat. 20° N / Long. 70° E, Dahanu, Malegaon, Pachmarhi, Jabalpur, Sidhi, Patna and Raxaul
13.	21 June	Remaining parts of Madhya Maharashtra, east Madhya Pradesh and Bihar, most parts of west Madhya Pradesh, east Uttar Pradesh, Uttarakhand and Himachal Pradesh, entire Jammu & Kashmir and some parts of west Uttar Pradesh	Lat. 20° N / Long. 60° E, Lat. 20° N / Long. 70° E, Dahanu, Ratlam, Jhansi, Lucknow, Pantnagar, Dehra Dun, Una and Jammu
14.	22 June	Some parts of north Arabian Sea, extreme southern parts of Gujarat State and some more parts of southwest Madhya Pradesh	Lat. 21° N / Long. 60° E, Lat. 21° N / Long. 65° E, Veraval, Surat, Ratlam, Jhansi, Lucknow, Pantnagar, Dehra Dun, Una and Jammu
15.	26 June	Some more parts of north Arabian Sea, south Gujarat State, west Madhya Pradesh and Uttar Pradesh, and some parts of east Rajasthan	Lat. 22° N / Long. 60° E, Lat. 22° N / Long. 65° E, Dwarka, Vallabh Vidyanagar, Sawai Madhopur, Gwalior, Lucknow, Pantnagar, Dehra Dun, Una and Jammu

TABLE 1 (Contd.)

S. No.	Date	Southwest monsoon advanced over:	Northern Limit of Monsoon Passed through
16.	2 July	Remaining parts of west Madhya Pradesh, Uttar Pradesh, Uttarakhand, Himachal Pradesh, most parts of Haryana, Chandigarh & Delhi and Punjab and some parts of east Rajasthan	Lat. 22° N / Long. 60° E, Lat. 22° N / Long. 65° E, Dwarka, Vallabh Vidyanagar, Bundi, Jaipur, Hissar and Bhatinda
17.	3 July	Some more parts of Gujarat State, most parts of east Rajasthan, remaining parts of Haryana, Chandigarh & Delhi & Punjab and some more parts of west Rajasthan	Lat. 22° N / Long. 60° E, Lat. 22° N / Long. 65° E, Dwarka, Surendranagar, Ajmer and Anupgarh
18.	4 July	Some more parts of Gujarat Region, remaining parts of east Rajasthan, and some more parts of west Rajasthan	Lat. 22° N / Long. 60° E, Lat. 22° N / Long. 65° E, Dwarka, Surendranagar, Jodhpur, Phalodi and Lat. 28° N / Long. 71° E
19.	5 July	Some more parts of north Arabian Sea, Kutch, remaining parts of Gujarat Region and some more parts of west Rajasthan	Lat. 24° N / Long. 60° E, Lat. 24° N / Long. 70° E, Jodhpur, Phalodi and Lat. 28° N / Long. 71° E
20.	13 July	Remaining parts of north Arabian Sea, Kutch and west Rajasthan and thus <b>covered the entire country</b>	

storm 'KYANT' and its movement led to enhancement of southwesterlies over southern most parts of Indian Seas. This caused delay in further withdrawal of southwest monsoon. As the storm weakened over west central Bay of Bengal off Andhra coast southwest monsoon withdrew from entire country on 28<sup>th</sup> October, 2016.

### 3. Chief synoptic features of southwest Monsoon 2016

The synoptic disturbances which affected the Indian Monsoon region during June, July, August & September are given in Tables 5 to 8 respectively. Track followed by the intense low pressure systems during the season are depicted in Fig. 8.

In all, 14 monsoon Lows (2 Deep Depressions, 2 Depressions, 3 well marked low pressure areas & 7 low pressure areas) formed against an average 6 Depressions. The first Depression (27<sup>th</sup> - 29<sup>th</sup> June) formed over northeast Arabian Sea and the second as a Land Depression (6<sup>th</sup> - 7<sup>th</sup> July) over northeast Madhya Pradesh and neighbourhood. Two Deep Depressions formed in August, viz., during (9<sup>th</sup> - 12<sup>th</sup> August) & (16<sup>th</sup> - 20<sup>th</sup> August) over coastal areas of West Bengal and neighbourhood and the other over northwest Bay of Bengal respectively. September was devoid of any intense low pressure system, other than the formation of a well-marked low pressure area and 2 low pressure areas.

The off-shore trough along different parts of the west coast persisted from 7<sup>th</sup> June - 3<sup>rd</sup> September except during 21<sup>st</sup> June, 13<sup>th</sup> - 16<sup>th</sup> July, 26<sup>th</sup> July, 28<sup>th</sup> July, 13<sup>th</sup> August - 22<sup>nd</sup> August and 27<sup>th</sup> August - 31<sup>st</sup> August. It was quite feeble from 7<sup>th</sup> June - 20<sup>th</sup> June, 7<sup>th</sup> July, 17<sup>th</sup> July - 25<sup>th</sup> July, 27<sup>th</sup> July, 31<sup>st</sup> July - 1<sup>st</sup> August, 7<sup>th</sup> August - 12<sup>th</sup> August, 25<sup>th</sup> - 26<sup>th</sup> August and 1<sup>st</sup> September.

### 4. Extra Indian features

#### 4.1. Cross equatorial flow

##### 4.1.1. Over the Arabian Sea

The Cross Equatorial flow along the equatorial belt (equator to 5° N/5° S) over Arabian Sea was stronger than normal in June and September except for the 3<sup>rd</sup> week of June in which it was weaker than normal. It was weaker than normal in 1<sup>st</sup> & 2<sup>nd</sup> week in July, close to normal in 3<sup>rd</sup> week but stronger than normal in 4<sup>th</sup> week. It was stronger than normal during August except in first week in which it is close to normal.

The surface winds over Arabian Sea to the north of 5° N were Close to normal in 1<sup>st</sup> and 2<sup>nd</sup> week of June but stronger than normal in 3<sup>rd</sup> and 4<sup>th</sup> week. It was weaker than normal in July and August except in 2<sup>nd</sup> week of August in which, it was close to normal. It was stronger than normal during September.

##### 4.1.2. Over the Bay of Bengal

The Cross Equatorial flow along the equatorial belt (equator to 5° N/5° S) over Bay of Bengal was Stronger than normal in June and close to normal in July except for the 4<sup>th</sup> week in which it was stronger than normal. It was stronger than normal in August and September except during 2<sup>nd</sup> week of both the months in which it was close to normal.

#### 4.2. Systems in west Pacific Ocean/south China Sea

There were in all 23 low pressure systems (reaching the intensity of Tropical depression and above) in the northwest Pacific Ocean / South China Sea during June-September 2016.

TABLE 2

Rainfall Figures (mm) for each month and season as a whole (June - September 2016)

S. Meteorological No. Sub-divisions	June			July			August			September			Monsoon		
	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)
1. A & N Islands	429.4	438.6	-2	301.2	407.7	-26	227.7	403.8	-44	604.3	432.4	40	1562.6	1682.5	-7
2. Arunachal Pradesh	379.4	500.4	-24	620.1	536.1	16	145.7	359.9	-60	532.9	371.6	43	1678.2	1768.0	-5
3. Assam & Meghalaya	369.0	502.3	-27	498.4	553.9	-10	185.3	410.3	-55	271.2	326.3	-17	1323.9	1792.8	-26
4. Naga, Mani, Mizo and Tri.	287.8	412.1	-30	326.2	415.0	-21	319.0	380.1	-16	296.0	289.7	2	1229.0	1496.9	-18
5. S. H. W. B. & Sikkim	570.8	485.2	18	732.1	615.8	19	209.9	495.2	-58	494.3	410.0	21	2007.1	2006.2	0
6. Gangetic West Bengal	172.7	244.4	-29	334.7	331.7	1	416.7	312.3	33	233.7	279.5	-16	1157.8	1167.9	-1
7. Odisha	164.2	214.1	-23	280.3	337.0	-17	320.8	362.1	-11	266.2	236.7	12	1031.5	1149.9	-10
8. Jharkhand	122.9	197.5	-38	301.0	334.6	-10	395.6	315.8	25	287.5	244.0	18	1107.0	1091.9	1
9. Bihar	128.7	168.5	-24	356.4	343.5	4	150.8	291.6	-48	357.9	224.0	60	993.9	1027.6	-3
10. East Uttar Pradesh	77.1	107.8	-28	338.1	298.0	13	224.4	294.5	-24	150.7	197.3	-24	790.3	897.6	-12
11. West Uttar Pradesh	60.0	71.1	-16	352.5	258.2	37	182.9	291.6	-37	44.7	148.5	-70	640.1	769.4	-17
12. Uttarakhand	174.4	167.8	4	508.4	428.1	19	308.5	426.3	-28	111.4	206.9	-46	1102.7	1229.1	-10
13. Haryana, Chandigarh & Delhi	35.8	45.9	-22	159.8	165.8	-4	133.0	173.6	-23	14.8	81.0	-82	343.3	466.3	-26
14. Punjab	52.6	44.4	18	153.1	186.0	-18	144.8	170.4	-15	17.4	91.1	-81	367.9	491.9	-25
15. Himachal Pradesh	101.3	95.4	6	194.0	306.9	-37	272.7	283.0	-4	56.8	140.0	-59	624.8	825.3	-24
16. Jammu & Kashmir	62.9	64.1	-2	193.0	192.4	0	181.8	186.0	-2	45.1	92.1	-51	482.7	534.6	-10
17. West Rajasthan	33.2	29.9	11	80.0	102.7	-22	191.9	89.3	115	11.0	41.3	-73	316.1	263.2	20
18. East Rajasthan	61.7	62.5	-1	326.2	225.2	45	385.6	228.4	69	40.2	99.7	-60	813.7	615.8	32
19. West Madhya Pradesh	111.1	105.4	5	432.9	291.6	48	394.8	308.7	28	100.8	170.4	-41	1039.6	876.1	19
20. East Madhya Pradesh	99.0	133.7	-26	552.2	347.8	59	462.3	369.7	25	139.6	200.0	-30	1253.1	1051.2	19
21. Gujarat Region	31.8	130.8	-76	255.8	341.2	-25	303.9	282.7	8	105.3	160.0	-34	696.9	914.7	-24
22. Saurashtra & Kutch	31.3	86.9	-64	110.0	188.2	-42	216.0	126.1	71	59.6	76.0	-22	416.9	477.5	-13
23. Konkan & Goa	806.5	698.1	16	1327.3	1110.0	19	817.0	760.2	7	600.2	345.4	74	3551.0	2914.7	22
24. Madhya Maharashtra	100.7	145.6	-31	319.6	242.2	32	232.7	189.1	23	171.9	152.4	13	824.9	729.3	13
25. Marathwada	157.3	143.3	10	276.1	187.2	47	89.2	188.2	-53	302.3	164.2	84	824.8	682.9	21
26. Vidarbha	165.5	168.0	-2	490.2	311.9	57	161.8	305.7	-47	227.8	169.0	35	1045.4	954.6	10
27. Chattisgarh	164.2	185.5	-12	361.0	377.5	-4	357.1	374.8	-5	295.6	215.0	37	1177.8	1153.3	2
28. Coastal Andhra Pradesh	189.1	103.9	82	131.5	160.4	-18	124.4	157.7	-21	224.4	159.1	41	669.4	581.1	15
29. Telangana	194.0	135.9	43	235.8	238.2	-1	133.7	218.8	-39	336.3	162.3	107	899.8	755.2	19
30. Rayalaseema	128.6	67.7	90	131.0	94.2	39	41.5	103.3	-60	90.8	133.1	-32	391.9	398.3	-2
31. Tamil Nadu & Puducherry	63.0	46.0	37	86.8	68.0	28	55.1	87.4	-37	49.0	115.8	-58	253.9	317.2	-20
32. Coastal Karnataka	963.1	867.7	11	763.1	1159.7	-34	471.3	755.5	-38	225.9	300.9	-25	2423.5	3083.8	-21
33. North Interior Karnataka	136.8	104.6	31	162.6	135.0	20	70.0	120.4	-42	155.0	146.0	6	524.3	506.0	4
34. South interior Karnataka	172.2	141.5	22	196.5	216.1	-9	85.9	161.4	-47	62.8	141.0	-55	517.4	660.0	-22
35. Kerala	595.7	649.8	-8	441.5	726.1	-39	231.0	419.5	-45	84.1	244.2	-66	1352.3	2039.6	-34
36. Lakshadweep	321.2	330.2	-3	262.6	287.7	-9	86.2	217.5	-60	75.6	163.1	-54	745.5	998.5	-25

TABLE 3

## Withdrawal of Southwest Monsoon 2016

S. No.	Date	Southwest monsoon withdrew from :	Withdrawal line passed through
1.	15 Sep	Some parts of west Rajasthan	Anupgarh, Bikaner and Jaisalmer
2.	28 Sep	The Southwest Monsoon further withdrew from some parts of Jammu & Kashmir, Punjab Haryana and some more parts of west Rajasthan	The withdrawal line passed through Kupwara, Kukernag, Pathankot, Ludhiana, Churu, Phalodi and Jaisalmer
3.	5 Oct	The Southwest Monsoon further withdrew from remaining parts of Jammu & Kashmir and Punjab, most parts of Himachal Pradesh and some more parts of Haryana & Chandigarh and west Rajasthan	The withdrawal line passed through Kalpa, Karnal Churu, Phalodi and Jaisalmer
4.	8 Oct	The Southwest Monsoon further withdrew from remaining parts Himachal Pradesh, Haryana, Chandigarh & Delhi, most parts of Uttarakhand, some parts of west Uttar Pradesh and east Rajasthan and some more parts of west Rajasthan	The withdrawal line passed through Dharchula, Aligarh, Jaipur and Barmer.
5.	12 Oct	The Southwest Monsoon further withdrew from remaining parts of Uttarakhand, west Uttar Pradesh and Rajasthan and some parts of east Uttar Pradesh, north Madhya Pradesh, north Gujarat State and north Arabian Sea	The withdrawal line passed through Bahraich, Nowgong, Shajapur. Ahmadabad, Okha, Lat. 23° N/Long. 65° E and Lat. 23° N/Long. 60° E
6.	14 Oct	The Southwest Monsoon has further withdrawn from remaining parts of east Uttar Pradesh, Madhya Pradesh, Gujarat state and north Arabian Sea and some parts of Bihar, Jharkhand, Chhattisgarh, Vidarbha, Marathwada, Ahmednagar, Mumbai, MadhyaMaharashtra, north Konkan (including Mumbai) and northern parts of central Arabian Sea	The withdrawal line passed through Darbhanga, Gaya, Champa, Brahmapuri, Lat. 19° N/ Long. 70° E and Lat. 19° N/Long. 60° E
7.	15 Oct	The Southwest Monsoon further withdrew from most parts of Bihar, Jharkhand, Chhattisgarh, some more parts of Marathwada, some parts of Gangetic West Bengal, Odisha and Telangana and remaining parts of Vidarbha	The withdrawal line passed through Forbesganj, Bankura, Angul, Jagdalpur, Ramagundam, Ahmednagar, Mumbai, Lat. 19°.0N / Long. 70°.0E and Lat. 19°.0N / Long. 60.0°E
8.	16 Oct	The Southwest Monsoon further withdrew from remaining parts of Bihar, Jharkhand, Sub-Himalayan West Bengal & Sikkim, Odisha, Chhattisgarh, Maharashtra & Goa states (including Pune) and Telangana; most parts of northeastern states, coastal Andhra Pradesh and north interior Karnataka and some parts of north and westcentral Bay of Bengal, Rayalaseema, coastal and south interior Karnataka and some more parts of central Arabian Sea	The withdrawal line passed through Lat. 26° N/ Long. 95° E. Imphal, Lat. 21° N/ Long. 90° E, Lat. 18° N / Long. 86° E, Ongole, Bellary, Karwar, Lat. 15° N / Long. 70° E and Lat. 15° N / Long. 60° E
9.	18 Oct	The Southwest Monsoon further withdrew from remaining parts of northeast India; most parts of northeast Bay of Bengal, some more parts of westcentral Bay of Bengal and most parts of coastal Andhra Pradesh, Rayalaseema, Karnataka and central Arabian Sea	The withdrawal line passed through Lat. 22° N/ Long. 94° E, Lat. 19° N/ Long. 90° E., Lat. 16° N/Long. 85° E., Tirupathi, Bengaluru, Mangalooru, Lat. 13° N/ Long. 70° E and Lat. 13° N / Long. 60° E
10.	28 Oct	<b>withdrew from the entire country</b>	

#### 4.3. Troughs in mid & upper westerlies affecting the Indian region to the south of 30° N

The number of troughs in mid & upper tropospheric westerlies affecting the Indian region which penetrated south of 30° N is 3 each in June, July and September and 4 in August at 300 hPa and 1 each in June, July and September and 2 in August at 500 hPa.

#### 4.4. Troughs in mid & upper tropospheric westerlies over the south Indian Ocean to the north of Lat. 30° S.

There were 35 troughs in mid & upper tropospheric westerlies which moved across the Indian Ocean from west to east, to the north of Lat. 30° S, in the Southern

Hemisphere, during June to September 2016. The month wise break-up is 8 in June & 9 each in July, August and September.

#### 4.5. Systems in southern hemisphere

##### 4.5.1. Tropical storms/depressions

During June-September 2016, only one Tropical Storm ABELA (16-19 July, 2016) was reported in Southern Hemisphere.

##### 4.5.2. Mascarene HIGH

The Mascarene HIGH with its mean position at 33.3° S / 67.4° E was stronger than normal by 3.7 hPa



TABLE 4

## Representative amounts of very heavy &amp; extremely heavy rainfall during June- Sept. 2016

Date	Some representative amounts of rainfall in cm for June, July, August September 2016 (12 cm and above)
1 Jun	Phulberia and Mannarkad 15 each
2 Jun	Vadakara 18, Quilandi and Kozhikode 15 each, Honavar, Vadakkancherry and Enamakal 13 each, Vaikom 12
3 Jun	Thalasserry 12
4 Jun	Garubathan 13
5 Jun	Vadakara 16
6 Jun	Alipurduar Cwc 21, Falakata and Alipurduar 13 each
7 Jun	Matijuri and Ponda each 13, B P Ghat 12
8 Jun	Alappuzha and Chengannur each 15, Mulde Agri and Punalur each 13, Motihari 12
9 Jun	Mawsynram and Shivani each 14, Enamakal, Vaikom, Ankola and Tarikere 12 each
10 Jun	Nil
11 Jun	Nil
12 Jun	Manki 13
13 Jun	Garubathan 26, Champasari 18, Panbari and Buxaduar 16 each, Dumka 15, Gajoldoba, Baghdogra AP and Narayanpur each 14, Bagrakote 13, Salbari, Rajnagar, Malbazar ARG, Rangiya and Pakuria 12 each
14 Jun	Kumargram and Bagrakote 22 each, Garubathan 19, Gajoldoba 17, Barobhisha 16, Quepem, Mohitnagar and Neora 15 each, Murti and Gossaigaon 14 each, Nh31 Bridge, Buxaduar and Jalpaiguri 13 each, Sanguem and Chepan 12 each
15 Jun	Alipurduar Cwc 23, Alipurduar 20, Dhubri Cwc and Dhubri 19 each, Barobhisha and Chepan 17 each, Chottabekra 16
16 Jun	Gohar 17, Ponda 13, Sundernagar 12
17 Jun	Nil
18 Jun	Udupi 16, Kumta 15, Kota, Manki, Shirali, Shirali PTO and Naharlagun 13 each.
19 Jun	Alipurduar Cwc 23, Mawsynram 15, Neora 13, Haldibari 12
20 Jun	Roha 18, Mawsynram 16, Nagari 15, Panambur 12
21 Jun	Baghdogra AP 24, Hasimara 21, Mawsynram 20, Gajoldoba 19, Chengmari / Diana 18, Buxaduar and Kota 17 each, Udupi and Cherrapunji 16 each, Murti and Gersoppa 15 each, Cherrapunji (Rkm) and Neora each 14, Nagarkata, Bundi and Jalpaiguri 13 each, Kundapur, Champasari and Dahanu 12 each
22 Jun	Devgarh 25, Alipurduar Cwc 23, Cherrapunji 18, Cooch Behar 17, Panjim (Goa) 16, Malvan, Marmugoa, Mormugao and Cherrapunji (Rkm) 15 each, Beki Mathungari, Chepan, Dabholim (Goa) and Bagaha 14 each, Mapusa and Rameshwaragri 13 each, Pernem, Williamnagar, Kollapur and Udai Kishanganj 12 each
23 Jun	Devgarh 15, Mangaluru 14, Rameshwaragri 13, Kudulu and Mani 12 each
24 Jun	Harnai 36, Williamnagar 24, Dondilohara and Aie Nh Xing 22 each, Bagrakote 20, Beki Mathungari 19, Khed, Dapoliagri and Gossaigaon 18 each, Guhagarh, Sevoke, Barobhisha, Wakwaliagri and Champasari 17 each, Chepan, Cooch Behar, Mhasla, Shriwardhan, Palgharagri and Kokrajhar 15 each, Manash Nh Xing and Kumargram 14 each, Balod, Alipurduar Cwc, Gaisilet ARG and Kantamal 13 each, Batli ARG, Palakurthi, Hemgiri, Khariar and Raighar ARG 12 each
25 Jun	Cooch Behar 22, Harnai and Palgharagri 21 each, Mhasla 19, Dapoliagri 17, Wakwaliagri and Mandangad 16 each, Guhagarh, Gossaigaon, Thane and Alibag 14 each, Pen, Roha, Sudhagad Pali, Barobhisha, Rosera, Devgarh and Mangaon 13 each, Chepan, Mathabhanga and Kumargram 12 each
26 Jun	Dahanu 25, Alibag 18, Uran, Harnai, Umergam, Guhagarh and Aswapuram 17 each, Palgharagri 15, Pen 14, Thane, Talasari, Raidih, Murud, Roha, Sathupalle, Tiruvuru, Shriwardhan and Ratnagiri 13 each, Prathipadu, Tala, Mumbai (Colaba), Panvelagri, Dapoliagri and Mhasla 12 each
27 Jun	Koida 18, Ratnagiri 16, Murud and Ramnagar 15 each, Harnai and Amalapuram 14 each, Jalpaiguri and Gohar 13 each, Vengurla, Armori and Gersoppa 12 each
28 Jun	Velairpad 23, Harnai 18, Vararamachandrapur and Nawanshahr 17 each, Ghumarwin 16, Jagdalpur and Hulikal ARG 15- each, Mhasla 14, Agumbe and Pernem 13 each, Panambur, Gondpipri, Kollur, Mangalooru AP, Mangaluru AP, Gersoppa, Dondilohara, Koida, Sawantwadi and Kundapur 12 each

TABLE 4 (Contd.)

Date	Some representative amounts of rainfall in cm for June, July, August September 2016 (12 cm and above)
29 Jun	Mananthavady 27, Bhagamandala, Mulchera, Kollur and Gersoppa 25 each, Agumbe 22, Murud 21, Honavar, Kumta and Chopda 20 each, Linganamakki HMS, Napoklu and Vararamachandrapur 19 each, Harnai and Sanguem 18 each, Kottigehara, Siddapura, Manki and Sawantwadi 17 each.; Mulakalapalle, Hosanagar and Kudal 16 each, Dharmasthala, Valpoi, Etapalli, Subramanya, Karwar, Dodamarg, Mulde Agri, Quepem, Marmugoa and Mormugao 15 each, Guhagarh, Thalaguppa, Vythiri, Kalasa, Siddapur, Ratnagiri, Pernem, Rameshwaragri, Dabholim (Goa), Mapusa, Ponda, Kammardi, Malvan and Canacona 14 each, Vengurla, Mhasla, Sringeri HMS, Lanja, Puttur HMS, Mudubidre, Jayapura, Medikeri, Burgampadu, Kankavli, Choryasi and Chinnakalar 13 each, G Bazar, Kadra, Ankola, Tala, Pen, Ponnampet Pwd, Sangameshwar Devrukh, Ahiri and Kampur 12 each
30 Jun	Ballarpur and Malbazar ARG 23 each, Rajura 22, Neora 18, Chengmari / Diana and Mulakalapalle 17 each, Bagrakote16, Murti, Tekulapalle and Bhagamandala 15 each, Kankavli, Pernem and Mogullapalle 14 each, Dodamarg, Agumbe, Govindaraopet, Venkatapur and Bhokar 13 each, Selu, Kukunoor, Velairpad, Mussoorie, Ponda and Chandrugonda 12 each
1 Jul	Harnai 29, Hasimara and WakwaliAgri 21 each, Gaunaha 18, Shriwardhan, Buxaduar and Jogindarnagar 17 each, Bhamragad and Mhasla 16 each, DapoliAgri and Sangameshwar Devrukh 15 each, Chengmari / Diana 14, Murud 13, Kapkot, Gajoldoba, Bhiwandi, Hulikal ARG, Tala, Khed and Mandangad 12 each
2 Jul	Harnai 25, Kheri Lakhimpur 23, Pernem 22, Bahraich 20, Arki and Mahabaleshwar* 19 each, Kottigehara, Bolangir and DapoliAgri 17 each, LonavalaAgri, Pen, Mahad and Hosanagar 16 each, Kankavli, Shahabad, PanvelAgri, Rajapur and Tala 15- each, GoalparaCwc, Khed, Sudhagad Pali, Khalapur, Banbasa, Bhiwandi, WakwaliAgri and Tumsar 14 each, Bhira, Vaibhavwadi, Gonda CWC, Chaukhutia, Baijnath, Devgarh, Murud, Shriwardhan, Poladpur and PalgharAgri 13 each, RameshwarAgri, Kolaras, Goalpara, Chamoli, Malsisar and Haldwani 12 each
3 Jul	Bhira 28, Sudhagad Pali 23, Rajula 21, Ramgarshshekhatan, Talasari, Pardi and LonavalaAgri 20 each, Gir Gadhada 19, Mahabaleshwar*, Roha and Serchip (Hydro) 18 each, Haraiya and Bhiwandi 17 each, Shahapur, Hulikal ARG and PanvelAgri 16 each, Pen, Murbad, Umergam, Jafrabad, Ulhasnagar, Kottigehara, Bhanupratappur, KarjatAgri and Vandsa 15 each, Una, Dahanu, Ambernath, Igatpuri, Mawsynram, Paud Mulshi and Daman 14 each, Khalapur, Mahad, Agumbe, Silvassa, Thane, Lathi, Pachmarhi, Babra, Kalpi CWC and Kalpi Tehsil 13 each, Khergam, Matheran, Kalyan, Poladpur, Madhbun, Siddapura, Valsad, Hindgir, Velhe and Ozarkheda - FMO 12 each
4 Jul	Mawsynram 27, Bhira 26, LonavalaAgri and Kherwara 23 each, Serchip (Hydro)20, Hulikal ARG and Mahabaleshwar* 19 each, Songadh 18, Cherrapunji, Vyara, Igatpuri and Cherrapunji (Rkm) 17 each, Paud Mulshi 16, Chatra and Agumbe 15 each, Matheran, Talasari, Akole, Agar and Jawhar 14 each, Ozarkheda - FMO, Ratlam, Ratlam - AWS, Garhi, Belthangadi, Bardoli, Vadgaon Maval, Surat and Kharsema 13 each, Sarangpur, Sagwara, Sudhagad Pali, Devel, Churk, Bhopalsagar, Shahera, Sawantwadi, Dharmasthala, Dhariabad, Shahapur, Ranchi AP, Rajgarh and Sabroom 12 each.
5 Jul	Deori 29, Mawsynram 22, Agumbe 21, Hulikal ARG 19, Shirali PTO and Mirzapur Tehsil 16 each, Cherrapunji, Kollur, Vengurla and Gersoppa 15 each, Churk, Cherrapunji (Rkm), Sawantwadi and Palkot 14 each, Siddapura, Basudevpur AWS, Malpur, Ghorawal and Ankola 13 each, Dharmasthala, Damoh, Damoh - AWS, Mudubidre and Kottigehara 12 each
6 Jul	Narsingpur 31, Harnai 22, Bonth 20, Ajaigarh 19, Shahabad and Attarra 18 each, Baheri, Barpeta and Nagode 17 each, Sidhi and Sidhi - AWS 16 each, WakwaliAgri, Khurai and Tendukheda 15 each, Khed and Dharmasala 14 each, Lakhnadon, Guna, Guna - AWS, Satna - AWS, Satna and Kareli 13 each, Begumganj, Maihar, Mahabaleshwar*, Bongaon, Karwi, Mawsynram, Beberu and DapoliAgri 12 each
7 Jul	Maihar 34, Hatta 29, Satna and Satna - AWS 28 each, Nagode 21, Damoh, Damoh - AWS and Buxwaha 19 each, Pachmarhi 17, Panna - AWS 15, Udaipura 13
8 Jul	Mandla - AWS 34, Satna and Satna - AWS 24 each, Mahroni and Buxwaha 17 each, Nighasan 16, Port Blair and Nainpur 13 each, Nagode 12
9 Jul	Hoshangabad 25, Saoli and Pachmarhi 22 each, Budhni 21, Chicholi 20, Dhanora and Nusrulgunj -Arg 18 each, Bhopal, Bhopal - AWS-Arg and Chamorshi 17 each, Hinganghat and Gadchiroli 16 each, Sindewahi, Sehore - AWS, Khategaon, Warora, Bhadravati, Betul, Betul - AWS and Mul 15 each, Ballarpur, Dhamangaon Rlwy, Itanagar, Chandrapur, Pombhurna, Mulchera, Chahtarpur - AWS, Raisen and Raisen - AWS 13 each, Chimur, Harda - AWS, Pandherikawara and Mahabaleshwar* 12 each
10 Jul	Bhamragad 30, Ahiri and Sehore - AWS 26 each, Pachpahar 23, Sarangpur, Chandgad, Nalkheda and Shujalpur 21 each, Sindewahi 18, Igatpuri and Mahabaleshwar* 17 each, Bakani, Ichhavar, Nusrulgunj -Arg and Mulchera 15 each, Khilchipur, Bichhia, Pirawa and Biaora 14 each, Radhanagari, Shahuwadi, Saoli and Kalingpong 13 each, Susner, Guna, Guna - AWS, Bhira and Nanipalson 12 each
11 Jul	Nandurbar 30, Mulchera 24, Mahabaleshwar* and Harsul - FMO 23 each, Nanipalson 22, Igatpuri and Dangs (Ahwa) 21 each, Peth 19, Pachmarhi 18, Satna Baglan, Tarana, Chikhalda and Dug 17 each, Shahuwadi, Ozar (Nasik AP) and Surgana 16 each, Sakri, Agumbe, Jawhar and Kalvan 15 each, Chamorshi, Etapalli, Khed, Seoni, Seoni - AWS, Rajapur, Patan and Shirala 14 each, Dindori, Kaprada, Radhanagari and Moradabad CWC 13 each, Bijapur, Subir, Mokheda - FMO, Neamatighat, Ozarkheda - FMO, Lanja, Bhamragad, Sangameshwar Devrukh, Gaganbawada and Kannad 12 each
12 Jul	Mahabaleshwar 29, Gadchiroli 24, Gaganbawada and Rajura 21 each, Chicholi and Radhanagari 20 each, Ballarpur 19, Nandura 18, Kinwat and Chamorshi 17 each, Pachmarhi, Korpana and Dharni 16 each, Khamgaon, Pombhurna, Rajapur and Desaignj 15 each, Shahuwadi, Murtajapur and Talasari 14 each, Dhanora, Kurkheda, Gargoti / Bhudargad, Patur, Hoshangabad, Bhainsdehi, Ajra, Raver, Malkapur, Mahur and Saoli 13 each, Ozarkheda - FMO, Kagal, Barshitakli, Peth, Khed, Betul, Betul - AWS and Lanja 12 each

TABLE 4 (Contd.)

Date	Some representative amounts of rainfall in cm for June, July, August September 2016 (12 cm and above)
13 Jul	Galiakot and Ichhawar 20 each, Meghraj 19, Mahabaleshwar*18, Vaibhavwadi, Dungarpur Tehsil and Unjha 15 each, Arnod, Arthuna, Gaganbawada, Chikali, Dungle and Railmagra 13 each, Radhanagari, Bagidora, Chandgad, Sagwara and Ashta -Arg 12 each
14 Jul	Railmagra 23, Mavli 17, Mawsynram 16, Tajewala15, Chhachhrauli 14, Manavadar 12
15 Jul	Dharmasala 17, Dadupur, Naharlagun, Bodh Gaya and Hamirpur CWC 15 each, Tekari, Jamshedpur AP, Sripalpur and Raidih 13 each, Ranjit Sagar Dam Site, Palampur, Bishrampur, Chhachhrauli and Dudhi 12 each
16 Jul	Mirzapur CWC 20, Todaraisingh 19, Chauldhowaghat 18, Banda CWC 17, Gaighat (Bla FMO), Jaley and Latehar 16 each, Anta 15, Banda, Panki and Silchar 14 each, Hindoli, Joshipur, Hindaun, Chunar, Ghosi, Gangapur and Rupbas 13 each, Karauli, Mawsynram and Islampur 12 each
17 Jul	Mawsynram 34, Roorkee 32, Jalesar 31, Cherrapunji 27, Cherrapunji (Rkm) and Mathura CWC 23 each, Haldwani 21, Deogaon Lalganj and Lalsot 19 each, Mirzapur Tehsil, Marmugoa and Mormugao 18 each, Sawai Madhopur 17, Nainital, Chothkabarwara, Laksar, Gangapur, Malerainadunger and Aligarh 15 each, Palmerganj, Sawaimadhpor Tesil, Mandrayal, Roing and Hasimara 14 each, Sirmari B.Pur, Sapotra, Chargharia, Azamgarh, Sapau, Gajoldoba, Williamnagar and Budhana 13 each, Jaunpur CWC, Ghazipur, Barh, Kaiserganj, Bageshwar (Thmo), Hindaun, Bhatpurwaghat, Muhammadbad (G), Moharo, Mukteswar and Deoband 12 each
18 Jul	Mawsynram 31, Cherrapunji 28, Cherrapunji (Rkm) and Budaun 20 each, Kasganj 19, Nazibabad 18, Forbesganj and Bawal 17 each, Nagina and Haldwani 16 each, Nongstain AWS and Kudal 15 each, Roorkee, Margao, Bishalgarh, Bagaha and Chhata 14 each, Pawayan and Sonamura 13 each, Gokulpur AWS, Mathura CWC, Udaipur, Mandawar, Mulde Agri, Kirawali and Hardwar 12 each
19 Jul	Mawsynram 55, Cherrapunji 45, Cherrapunji (Rkm) 40, Roing 18, Taibpur 16, Malbazar ARG and Gajoldoba 15 each, Neora 14, Tala 13, WakwaliAgri, Kalyan, Nongstain AWS, Mangaon and Roha 12 each
20 Jul	Cherrapunji 34, Mawsynram 27, Cherrapunji (Rkm) 26, Harnai 18, Chepan 17, Roha, Birpur and Mhasla 14 each, Buxaduar, Rajapur, Bagrakote, Bhiwandi, Murud, Guhagarh and Shriwardhan 13 each, Kankavli, Sawantwadi, Haldibari, Uran, Sevoke and Ponda 12 each.
21 Jul	Mawsynram 47, Chittapur 29, Cherrapunji 23, Cherrapunji (Rkm) 21, Sevoke 18, Forbesganj and Harnai 17 each, Williamnagar, Sedam and Chanderdeepghat 15 each, Akkalkot, Dahanu, Panbari, Taibpur, Malvan, Salbari, Gulbarga and Kalaburgi 13 each, Murud and Thakurganj 12 each
22 Jul	Messenjore 25, Buxaduar 21, Murti 19, Agumbe and Nagarkata 18 each, Mawsynram17, Roing and Aonla 16 each, Chengmari / Diana, Malbazar ARG and Neora 15 each, Bikapur and Pakuria 13 each, Cherrapunji (Rkm), Passighat, Champasari and Siliguri ARG 12 each.
23 Jul	Cherrapunji and Bagrakote 28 each, Mawsynram and Cherrapunji (Rkm) 23 each, Hasimara 21, Harnai 19, Cooch Behar 18, Jagadhari, Ajaigarh, Barobhisha and Sevoke 17 each, Mathabhanga and Dinhati 16 each, Buxaduar 15, Kotdwar, Srinagar, Falakata, Murti, Chengmari / Diana and Deoprayag 14 each, Moradabad CWC, Miao, Garubathan, Neora, Chepan and Fatehpur Tehsil 13 each, Passighat, Banbasa, Palliakalan, Alipurduar, Asifabad, Thakurdwara and Roing 12 each
24 Jul	Cherrapunji (Rkm) 39, Cherrapunji 38, Siliguri ARG and Mawsynram 35 each, Gajoldoba 33, Nagarkata 31, Chengmari / Diana, Champasari and Baghdogra AP 28 each, Murti 25, Buxaduar 24, Neora 21, Malbazar ARG 20, Salbari 19, Roing 18, Tehri 17, Hasimara, Passighat and Galgalia 15 each, Harnai and Sandila 14 each, Falakata and DapoliAgri 13 each, Shriwardhan and Nh31 Bridge 12 each
25 Jul	Roing 32, Cherrapunji 29, Mawsynram and Buxaduar 21 each, Cherrapunji (Rkm) 20, Passighat and Domohani 17 each, Nh31 Bridge, Jalpaiguri and Sindhked Raja 15 each, Galgalia and Shahera 13 each, Siliguri ARG and Morva Hadaf 12 each
26 Jul	Mawsynram 32, Goibargaon, Cherrapunji and Baghdogra AP 17 each, Chepan and Cherrapunji (Rkm) 16 each, Salbari and Yercaud 15 each, Naraingarh, Hasimara, Morni, Marandahalli, Melabazar / Matunga, Alipurduar CWC and Siliguri ARG 14 each, Champasari, Kumargram, Buxaduar, Gajoldoba and Tindivanam 13 each, Sevoke, Williamnagar, Tirupuvanam, Chengmari / Diana, Falakata and Narmetta 12 each
27 Jul	Madhopur 19, Kangra AP 17, Kathua and Jammu IAF 16 each, Palampur, Ranjit Sagar Dam Site and Shahpur Kandi 15 each, Hosur 14, Shajapur and Shajapur - AWS 13 each, Dharmasala, Jhansi, Ukhimath, Patan, Malakpur and Jogindarnagar 12 each
28 Jul	Sindhked Raja 20, Kotri and Hurda 15 each, Arnod, Jammu IAF and Chhota Udepur 13 each; Bagaha 12
29 Jul	Shahpura 22, Muzaffarnagar 13, PalgharAgri 12
30 Jul	Khambhalia 21, Alibag 19, Dahanu 15, N. Delhi (PLM), Sujanpur Tira and Harnai 14 each, Erinpura Rd., Sumerpur and Hathras 13 each, Jafarpur AWS 12
31 Jul	Vapi 22, Madhwapur 20, Renapur 18, Baheri 17, Silvassa and Jamjodhpur 16 each, Palliakalan 14, Talasari, Madhbun, Harnai and Hamirpur CWC 13 each, Bareilly CWC, Chandrapur, Sambhal, PalgharAgri, Chiplun and Tala 12 each
1 Aug	Karjatagri 29, Metpalle and Roha 22 each, Thane and Kalyan 21 each, Misrikh 20, Panvelagri, Mhasla, Ulhasnagar, Murud and Palgharagri 19 each, Ambernath and Ayoadhya 18 each, Bhiwandi, Dharmasala, Matheran, Tala, Diamond Harbour and Mangrol 17 each, Lonavalaagri, Nighasan, Sudhagad Pali and Mortad 16 each, Mandangad, Pen, Harnai, Shriwardhan and Nahan 15 each, Tarabganj, Balkonda, Wada, Bhira, Kammar Palle and Khalapur 14 each, Vikramgad, Mavli, Budhni, Murbad and Hoshangabad 13 each, Poladpur, Mahad, Sultanpur, Shriramsag.Pocha and Mahabaleshwar 12 each

TABLE 4 (Contd.)

Date	Some representative amounts of rainfall in cm for June, July, August September 2016 (12 cm and above)
2 Aug	Mahabaleshwar 39, Dharampur 35, Pardi 31, Vapi 29, Daman 27, Poladpur 26, Kaprada 25, Talasari and Mahad 23 each, Nanipalson 22, Mandangad, Silvassa, Harnai, Bhanupratappur, Sawantwadi, Chandgad and Dharamasala 21 each, Vikramgad, Wada, Harsul - FMO and Ozarkheda - FMO 20 each, Mangaon and Pachmarhi 19 each, Jawhar, Mokhedra - FMO, Mhasla and Madhbun 18 each, Dahanu, Kanker and Khed 17 each, Umergam, Khergam and Wakwaliagri 16 each, Palgharagri, Danpur and Bhira 15 each, Rengali, Roha, Dindori, Dapoliagri, Chiplun, Tala, Akole, Surgana and Kanva 14 each, Lanja, Shriwardhan, Waghai, Naktideul, Canning Town., Sudhagad Pali, Peth, Ratnagiri and Shahapur 13 each, Murud, Sangameshwar Devrukh, Mulde Agri, Bhungra, Gandevi and Manmothnagar 12 each
3 Aug	Mahabaleshwar 41, Mokhedra - FMO 29, Vikramgad 27, Harsul - FMO 26, Mandangad 23, Mahad and Velhe 22 each, Ozar (Nasik AP), Bhira and Jawhar 20 each, Cooch Behar and Igatpuri 19 each, Bakani, Poladpur, Wai and Ozarkheda - FMO 18 each, Suvasara, Akole and Nimbahera 17 each, Mangaon and Mahidpur 16 each, Lakhanpur ARG, Talasari, Nanipalson, Shriwardhan, Thandla, Silvassa and Roha 15 each, Murbad, Matheran and Pirawa 14 each, Kaprada, Javali Medha and Susner 13 each, Chothkabarwara, Garoth, Paud Mulshi, Satara, Peth, Raigarh, Mhasla, Udaipura, Ambabhona and Shahapur 12 each
4 Aug	Sambalpur, Sailana and Mahabaleshwar 24 each, Burla ARG and Siwana 20 each, Vidisha - AWS, Bhira and Ratlam - AWS 19 each, Chendipada and Hirakud 17 each, Igatpuri 16, Chandgad, Naktideul and Danpur 15 each, Lateri 14, Rairakhhol, Aspur, Nimpara, Harda - AWS and Contai 13 each, Dharampur, Mangaon, Paud Mulshi, Velhe, Loharia, Khanapur and Radhanagari 12 each
5 Aug	Khambhalia 23, Lalpur 20, Sambalpur and Mahabaleshwar* 16 each, Kantamal, Tarva ARG and Sonepur 15 each, Agumbe and Bhanvad 14 each, Rairakhhol and Radhanagari 13 each, Bolangir, Hulikal ARG, Kakatpur, Kotagarh, Ambadola and Jamjodhpur 12 each
6 Aug	Dhrol 34, Kalavad 27, Mahabaleshwar 24, Khambhalia and Dhrol ARG 23 each, Lonavalaagri 22, Kaprada and Jamjodhpur 21 each, Umergam and Lalpur 19 each, Gaganbawada and Raigarh 18 each, Silvassa, Paddhari, Matheran, Sangameshwar Devrukh, Kagal and Kangra AP 17 each, Madhbun and Jogindarnagar 16 each, Sujanpur Tira, Radhanagari, Bhanvad, Talasari, Vikramgad, Thakurdwara and Nagrota Surian 15 each, Bhira, Mumbai (SCZ), Waghai and Agumbe 14 each, Nadaun, Lodhika, Rajapur, Jawhar, Dharampur and Karjatagri 13 each, Jamshedpur AP, Sagarisland AWS, Shahpur Kandi, Igatpuri, Vadgaon Maval, Dahanu, Dehra Gopipur, Ranavav and Mahad 12 each
7 Aug	Shahpur Kandi and Dehra Gopipur 20 each, Kota AP 19, Ghumarwin and Guler 18 each, Katra and Nagrota Surian 17 each, Aklera and Begumganj 16 each, Ranjit Sagar Dam Site and Mukerian 15 each, Waghai, Bhanupratappur, Phangota and Ladpura 14 each, Jammu City, Madhopur, Velhe, Udhampur IAF and Nakhatrana 13 each, Pathalgaon, Kollur, Kaprada, Hulikal ARG and Siddapura 12 each
8 Aug	Chittorgarh 23, Chambal / R.B.Dam and Gangrar 21 each, Begu 19, Mangrol 16, Rashmi 15, Masuda and Tusuma 14 each, Degod and Bhanpura 13 each, Guhla, Bhainsroadgarh, Anta, Attarra, Ramganjmandi and Ashoknagar - AWS 12 each
9 Aug	Begu 34, Chittorgarh 26, Gangrar 22, Pali and Badesar 20 each, Sahada and Nimbahera 19 each, Mandargarh 18, Rohat and Mandal 17 each, Bijoliya, Rashmi and Devel 16 each, Sojat 15, Pisagan, Jawad, Banera and Pratapgarh 13 each, Kumbhalgarh, Nimach and Mahabaleshwar 12 each
10 Aug	Bali 29, Jamshedpur AP 22, Karimganj 19, Jodhpur Tehsil 18, Pardi, Jodhpur AP, Mount Abu and Mounntabu Tehsil 17 each, Deganga and Desuri 16 each, Rohat 15, Vadodara City, Jamshedpur, Chandanpur, Modasa, Bareilly Cwc, Ahore and Haldwani 14 each, Ghumarwin, Sojat, Dhansura, Jalore, Marwar Junction, Sheoganj, Raniwada, Manmothnagar, Kadana and Bhograi 13 each, Pindwara and Daman 12 each
11 Aug	Krishnanagar and Mandawar 17 each, Bongaon, Mangalkote and Bonli 16 each, Maithon 14, Krishnanagar, Neemkathana and Mukerian 13 each
12 Aug	Chatra 24, Nadaun 22, Nagrota Surian and Beri 21 each, Dujana 19, Panki and Bishrampur 17 each, Guler 16, Churk, Dehra Gopipur and Ramanujanj 15 each, Daltonganj and Manatu 14 each, Garhwa, Banganaf, Ghorawal and Mehre (Barsar) 13 each, Robertsganj, Ghamroor and Madhupur 12 each.
13 Aug	Cherrapunji 18, Janakpur 17, Chunar 14, Baikunthpur and Ambikapur 13 each, Cherrapunji (Rkm) 12
14 Aug	Kamalpur and Ganjbasoda 17 each, Haldwani and Mangrol 16 each, Dharmanagar / Panisagar 14
15 Aug	Kunda 28, Fursatganj 24, Rae Bareilly Cwc 19, Kamalpur 16
16 Aug	Ajaigarh 14, Telkoi 13, Nagode 12
17 Aug	Rajkanika and Maihar 18 each, Nagode, Chandbali, Satna and Satna - AWS 17 each, Haldwani 16, Binjharpur ARG 15, Ajaigarh and Khajurao 14 each, Rajnagar, Pattamundai, Kotma, Bari ARG and Dhamnagar ARG 13 each, Rewa, Rewa - AWS, Umariya, Umariya - AWS, Akhuapada and Mau Tehsil 12 each
18 Aug	Jamshedpur AP 27, Jamshedpur 24, Tiring 15, Kathumer, Latehar and Rairangpur 14 each, Chandil, Nimdih, Purihansa and Dhanbad 13 each, Putki, Tenughat, Kharidwar and Nagar 12 each
19 Aug	Maihar 28, Nagaon and Nagode 21 each, Panna - AWS 19, Ajaigarh 18, Rajnagar, Ramanujanj and Chahtarpur - AWS 17 each, Gudh 15, Banda Cwc, Rewa, Rewa - AWS and Khajurao 14 each, Satna - AWS and Satna 13 each, Banda, Mauranipur, Beberu and Rath 12 each

TABLE 4 (Contd.)

Date	Some representative amounts of rainfall in cm for June, July, August September 2016 (12 cm and above)
20 Aug	Manohar Thana 31, Biaora and Chipabarod 25 each, Kurwai 21, Chabra 20, Khurai and Buxwaha 19 each, Aklera and Mahroni 17 each, Sagar, Sagar - AWS, Rajgarh and Ganjbasoda 16 each, Lateri and Begumganj 15 each, Raisen, Raisen - AWS, Narsingarh and Hatta 14 each, Damoh, Damoh - AWS, Garhakota and Atru 13 each, Isagarh 12
21 Aug	Sailana 30, Danpur, Arnod, Badesar and Nimbahera 23 each, Bari -Sadri and Pipalkhunt 22 each, Chhotisadri and Dhariabad 21 each, Ratlam - AWS 20, Agar and Pratapgarh 18 each, Pirawa, Ujjain, Gautampura and Ujjain - AWS 17 each, Gangrar, Dungla, Jaora and Nimach 16 each, Vidisha - AWS, Khachrod and Jawad 15 each, Tarana, Susner, Sarangpur and Ghatol 14 each, Dug, Belonia, Balachaur, Suvasara, Jagpura, Chittorgarh, Badnagar, Depalpur and Khilchipur 13 each, Badnawar, Tonkhurd, Naina Davi, Shajapur, Biaora, Shajapur - AWS and Bhungra 12 each
22 Aug	Kanksa BSF, Panagarh AP and Harinkhola 20 each, Joypur, Burdawan and Krishnanagar 19 each, Manteswar and Kalna 18 each, Bankura, Bankura Cwc, Kashipur, Mankar and Burdwan 17 each, Durgapur 16, Balagarh 15, Gheropara, Indus, Panchet and Bolpur 14 each, Ranaghat, Bagati (Magra), Garubathan, Hatwara, Sriniketan and Bongaon 13 each, Nagarkata, Dhaniakhali, Pipalkhunt, Kalyani Smo and Arambagh 12 each
23 Aug	Kumbhagarh 13
24 Aug	Modasa 17, Meghraj 15, Vadgam 14, Desuri and Palanpur 13 each, Kadra and Bhira 12 each
25 Aug	Radhanpur 19, Santalpur 14
26 Aug	Paralakhemundi 14, Ranpur, Seoni and Seoni - AWS 12 each
27 Aug	Port Blair 18, Jogindarnagar and Umerpada 14 each, Harnai, Sukma and Garhakota 13 each, Seoni, Seoni - AWS and Uran 12 each
28 Aug	Patan 14, Bhatinda 13, Phagwara 12
29 Aug	Cooch Behar 17, Falakata
30 Aug	Duvvur 23, Nandyal 19, Dhrol and Kollapur 16 each, Simhadripuram 15, Proddutur 14, Chapad 13, Dharmanagar / Panisagar and Kalkalur 12 each
31 Aug	Peddemul 22, Pargi 21, Bhinmal 16, Sandila, Gandede and Parvathagiri 13 each, Champasari, Mannargudi, Rentachintala, Basaralu and Bagrakote 12 each
1 Sep	Passighat 19, Moradabad CWC 18, Roing 16, Gautam Buddha Nagar 15
2 Sep	Mawsynram 46, Cherrapunji 30, Cherrapunji (Rkm) 29, Passighat 27, Barobhisha 16, Roing 15, Alipurduar CWC and Gossaigaon 13 each
3 Sep	Cherrapunji (Rkm) 21, Mawsynram 17, Cherrapunji 15, Domohani 14, Jalpaiguri 13, Bagrakote 12
4 Sep	Chandanpur, Padampur and Ramnagar 17 each, Patnagarh and Burla ARG 16 each, Sambalpur 15, Lahunipara, Atabira ARG, Rewaghat and Binika 13 each, Hirakud, Ghatsila, Kesinga ARG, Kharidwar, Gaunaha and Saintala ARG 12 each
5 Sep	Binika 13, Jamsolaghat, Tamulpur, Tirtol ARG and Suryagadha 12 each
6 Sep	Tekari 26, Gaya AP 24, Both Gaya 20, Bikram, Kuratha and Purihansa 17 each, Koilwar, Kinjar and Jamshedpur AP 16 each, Makhdumpur and Kharidwar 15 each,; Jamshedpur and Harinkhola 14 each, Arambagh, Matijuri, Kolkata and Chandil 13 each, Phulberia 12
7 Sep	Port Blair 20, Sono and Rajdhanwar 12 each
8 Sep	Jalalpor and Pardi 14 each, Gajoldoba 13, Choryasi 12
9 Sep	Passighat and Roing 12 each
10 Sep	Chatia 22, Deogarh 19, Dumri 16, Sohela, Kosagumda and Motihari 13 each, Buxaduar 12
11 Sep	Mul 19, Karimnagar and Gondpipri 17 each, Chamorshi 16, Saoli 15, Garubathan 14, Sapaul, Korchi, Alipurduar, Latehar, Kurkheda and Pombhurna 13 each, Thimmapur 12
12 Sep	Rewaghat 23, Salekasa 19, Mawsynram 17, Amgaon 16, Patna AP and Araria 13 each, Marsrakh and Bagrakote 12 each
13 Sep	Jangamaheswarapuram 23, Nighasan 18, Macherla and Chimakurthi 17 each, Mundlamuru 16, Sandila and Ongole 15 each, Karamchedu 14, Darsi and Haldwani 13 each, Konta 12
14 Sep	Nil
15 Sep	Chitaguppa 19, Humnabad 15, Chevella 14, Devanakonda 12
16 Sep	Dahanu 35, Visavadar 17, PalgharAgri 14, Waghai 12
17 Sep	Harnai 29, Mahabaleshwar 24, Murud 23, Uran 18, Mhasla 17, Poladpur and Roha 16 each, Mandangad 15, DapoliAgri 14, WakwaliAgri and Mirzapur CWC 13 each, Khed and Umarga 12 each



TABLE 4 (Contd.)

Date	Some representative amounts of rainfall in cm for June, July, August September 2016 (12 cm and above)
18 Sep	Pen 24, Lonavala Agri 19, Bhira and Mahabaleshwar 17 each, Daparijo 16, Sudhagad Pali 15, Vadgaon Maval and Khalapur 14 each, Mangaon 13 Gaighat (Bla FMO) 12
19 Sep	Harnai 17, Dapoli Agri 15, Palsana and Upleta 14 each, Dhoraji 13, Wakwali Agri, Jetpur, Jalalpor, Visavadar and Mahabaleshwar 12 each
20 Sep	Galgalia 18, Garubathan 14, Dondilohara and Bagrakote 13 each, Gangtok 12
21 Sep	Dahanu 53, Palghar Agri 31, Motihari 24, Hakimpet 17, Jaunpur CWC 16, Ghanpur, Palakurthi, Mulakalapalle and Daman 15 each, Bhadravati and Mumbai (SCZ) 14 each, Shamirpet, Tadepalligudem and Naharlagon 13 each, Kukatpally Jntu (Arg), Burdawan and Umergam 12 each
22 Sep	Pen 32, Harnai 22, Umergam 17, Chiplun and Sattenapalle 16 each, Chorgharia, Banbasa, Mumbai (Colaba) and Car Nicobar 15 each, Uran 14, Poladpur, Mahad, Sudhagad Pali and Girnadam - FMO 13 each, Roha, Amalapuram, Daman, Machilipatnam and Bahadurganj 12 each
23 Sep	Khed 30, Mhasla 24, Roha 21, Piduguralla 20, Matheran and Tala 19 each, Dharmasagar and Pen 18 each, Kampasagar AP, Humnabad and Wakwali Agri 17 each, Santhapur and Mandangad 16 each, Lingampet and Tadwai 15 each, Aurad, Ghanpur, Harnai and Pitlam 14 each, Kalg, Nalgonda, Sadasivanagar, Jukkal, Chiplun, Gandhari, Miryalaguda, Khanapur, Kothagudem and Bidar 13 each, Hanamkonda, Dapoli Agri, Yellareddy, Koyyalagudem, Mominpet and Narmetta 12 each
24 Sep	Armur 39, Pen and Roha 22 each, Murud, Madnur, Ranjal, Nirmal and Bodhan 20 each, Alibag, Nandipet and Balkonda 19 each, Jakranpalle and Velpur 18 each, Ratnagiri, Uran and Mumbai (Colaba) 17 each, Sudhagad Pali, Navipet, Tadwai, Basti and Tuting 16 each, Makloor, Yeda Palle, Basti CWC, Mortad, Khed, Matheran and Lanja 15 each, Wakwali Agri, Lingampet and Sangameshwar Devrukh 14 each, Harnai, Palam, Varni, Kotgiri, Mudhole and Kamareddy 13 each, Jukkal, Rudrur AP, Alipurduar CWC, Beed, Manjlegaon, Dich Palle, Guhagarh, Indapur, Utnur and Gudurwrgl 12 each
25 Sep	Machareddy 32, Kamareddy 27, Mathabhanga 24, Rafiganj 19, Vaibhavwadi and Jakranpalle 17 each, Cooch Behar and Harnai 16 each, Bhadravati, Azamgarh, Nh31 Bridge, Deogaon Lalganj, Sherghati and Tribeniganj 15 each, Tuting, Madhipura, Gambhiraopet and Haldibari 14 each, Falakata, Medchal, Mangan, Phulparas, Alipurduar, Alipurduar CWC and Ramayampet 13 each, Pachhad, Mohammedabad (Y), Chandrapur, Sadasivanagar and Domakonda 12 each
26 Sep	Sadakarjuni 17, Tuting 13, Kishanganj and Maheshpur 12 each
27 Sep	Daparijo 16, Bhanupratappur 12
28 Sep	Janjgir 13
29 Sep	Allahabad AP 14, Niali ARG 13
30 Sep	Pathapatnam 13

during the monsoon period June to September. It was above normal by 5.9, 6.6, 0.4 & 1.8 hPa during the months of June, July, August and September respectively.

## 5. Semi - permanent systems

### 5.1. Heat low

This year, the Heat Low gradually strengthened and got established in its near normal position in the first week of June. It was mostly seen in its near normal position all through the season and The Heat Low started gradually filling up from first week of September. It became less marked in the first week of October.

### 5.2. Monsoon trough

This year, the prevailing 'High Index' phase of mid latitude circulation regime restrained the Western Disturbances to higher latitudes during the May month thereby leading to below than normal mean sea level

pressure anomalies over the northwest, west and central India. Subsequently, a shallow heat trough was noticed and maintained along the Indo-Gangetic plains during the June month. With the southwest monsoon covering the entire country, this trough got established as the monsoon trough south of its normal position on 13<sup>th</sup> June.

The monsoon trough remained in its near normal position for couple of days and shifted to north of its normal position on 16<sup>th</sup> and then close to foothills of Himalayas during 19<sup>th</sup> - 21<sup>st</sup> July. It shifted back to its normal position on 22<sup>nd</sup> whereas the east end of the trough was seen south of its normal position upto 25<sup>th</sup> July. Thereafter, both the ends were seen oscillating north - south of its normal position upto 2<sup>nd</sup> August. The trough became active as it shifted south of its normal position with embedded monsoon Lows during 3<sup>rd</sup> - 10 August. Thereafter, the western end of the monsoon trough started shifting northwards from 14<sup>th</sup> August and lay close to foothills of the Himalayas on 17<sup>th</sup> August whereas the eastern end remained close to its normal position. In the

TABLE 5

## Details of the weather systems during June 2016

S. No.	System	Duration	Place of initial location	Direction of movement	Place of Final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>(A) Depression</b>						
1.	Depression	27 (0900 UTC)- 29 (0000 UTC)	Northeast Arabian Sea and neighbourhood near Lat. 21.5° N/ Long. 64.5° E	West southwest	Northwest Arabian Sea near Lat. 20.3° N/ Long. 62.3° E	Details are given in the article on Storms & Depressions over the north Indian Ocean - 2016
<b>(B) Well marked low pressure area</b>						
1.	Low Pressure area	26 - 28	West central and adjoining northwest Bay of Bengal off south Odisha- North Andhra Pradesh coast	Northwest	Chhattisgarh and adjoining areas of Odisha & Vidarbha	A cyclonic circulation extending between lower & mid tropospheric levels lay around over west central and southwest Bay of Bengal off Andhra Pradesh coast during 22-25. Under its influence a low pressure area formed on 26 and became less marked on 29. However, associated cyclonic circulation extending upto lower levels persisted over south Chhattisgarh and neighbourhood which merged with the east-west trough on 30
<b>(C) Western disturbances /Eastward moving systems</b>						
<i>(i) Upper air cyclonic circulation</i>						
<i>(ii) As a trough</i>						
1.	Mid & Upper tropospheric levels	1 - 11	Along Long.50° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Northeast	Along Long.90° E to the north of Lat. 25° N (axis at 5.8 kms a.s.l.)	Moved away northeastwards on 12
2.	Upto Mid tropospheric levels	8 - 14	Along Long.50° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Do	Along Long.78° E to the north of Lat. 28° N (axis at 5.8 kms a.s.l.)	Moved away northeastwards on 15
3.	Do	14 - 19	Along Long.60° E to the north of Lat. 35° N (axis at 5.8 kms a.s.l.)	Do	Along Long.72° E to the north of Lat. 32° N upto 3.1 kms a.s.l. on 15 & 16. Moved (axis at 5.8 kms a.s.l.) away northeastwards on 20	It lay as a cyclonic circulation extending
4.	Do	22 - 23	Along Long.62° E to the north of Lat. 35° N (axis at 5.8 kms a.s.l.)	East	Along Long.66° E to the north of Lat. 35° N (axis at 5.8 kms a.s.l.)	Moved away east northeastwards on 24
5.	Do	27 - 30	Along Long.62° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Do	Along Long.75° E to the north of Lat. 35° N (axis at 5.8 kms a.s.l.)	Moved away east northeastwards the evening of 30 June
6.	Do	29 June - 6 July	Along Long.55° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Do	Along Long.79° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	It moved away northeastwards on 7 July
<i>(iii) As an Induced cyclonic circulation</i>						
1.	Upto lower tropospheric levels	16 - 18	Punjab and adjoining northwest Rajasthan	East	Haryana and adjoining north Rajasthan	Became less marked on 19
<b>(D) Other upper air cyclonic circulations</b>						
1.	Upto lower tropospheric levels	1 - 4	South Chhattisgarh and neighbourhood	East	Interior Odisha and neighbourhood	Became less marked on 5
2.	Between lower & mid tropospheric levels	2 - 8	Southwest and adjoining west central Bay of Bengal off Andhra Pradesh coast	North	West central and adjoining northwest Bay of Bengal off north Andhra Pradesh-south Odisha coast	Became less marked on 9

TABLE 5 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.	Upto lower tropospheric levels	4 - 6	Southwest Madhya Pradesh and neighbourhood	Do	West Madhya Pradesh and adjoining east Rajasthan	Merged with the trough extended from northwest Rajasthan to Odisha on 7
4.	Upto Mid tropospheric levels	9 - 12	Bangla Desh and adjoining north Bay of Bengal	East	Assam & Meghalaya and neighbourhood	Became less marked on 13
5.	Upto lower tropospheric levels	12 - 14	Northern parts of Bihar and adjoining Sub-Himalayan West Bengal & Sikkim	Stationary	<i>In situ</i>	It merged with the cyclonic circulation over Sub-Himalayan West Bengal & Sikkim and neighbourhood on 15
6.	Do	14 - 15	Northern parts of Haryana and adjoining areas of west Uttar Pradesh & Uttarakhand	Do	Do	Became less marked on 16
7.	At lower level	15	East Uttar Pradesh and neighbourhood	Do	Do	Merged with the east-west trough on 16
8.	Upto Mid tropospheric levels	15 - 16	Sub-Himalayan West Bengal and neighbourhood	East	Bangla Desh and neighbourhood	Initially it lay as a north-south trough between 1.5 & 3.6 kms a.s.l. on 14. Became less marked on 17
9.	Do	16 - 21	West central Bay of Bengal off north Andhra Pradesh coast	West	Marathwada and adjoining Vidarbha	Became less marked on 22
10.	Upto lower tropospheric levels	20 - 21	Southwest Madhya Pradesh and neighbourhood	Do	South Rajasthan and adjoining Gujarat Region	It lay embedded in the east west trough and became less marked on 22
11.	Between Lower & mid tropospheric levels	21	West Uttar Pradesh and neighbourhood	Stationary	<i>In situ</i>	Became less marked on 22
12.	Upto lower tropospheric levels	23 - 24	Punjab and neighbourhood	East	West Uttar Pradesh and neighbourhood	Became less marked on 25
13.	Between Lower & mid tropospheric levels	25 - 26	Northwest Madhya Pradesh and neighbourhood	Stationary	<i>In situ</i>	Became less marked on 27
14.	Upto lower tropospheric levels	29	Southeast Rajasthan and neighbourhood	Do	Do	It lay embedded with the east-west trough and merged in it on 30
<b>(E) East-West trough</b>						
1.	At mean sea level	15 June - 12 July	From Punjab to Tripura across Haryana, Uttar Pradesh, Bihar and Bangla Desh	Oscillatory	From Punjab to northeast Bay of Bengal across south Haryana, centre of low pressure area, north Chhattisgarh, Jharkhand and Gangetic West Bengal	It established as a Monsoon Trough on 13 July
<b>(F) Other troughs / Wind Discontinuity</b>						
1.	Upto lower tropospheric levels	5 - 11	From Haryana to Telangana across northeast Rajasthan, west Madhya Pradesh and Vidarbha	Oscillatory	Northwest Rajasthan to northeast Bay of Bengal across Uttar Pradesh, Bihar, Jharkhand and Gangetic West Bengal	Became less marked on 12
<b>(G) East-West shear zone</b>						
1.	Mid tropospheric levels	19 - 26	Along Lat. 10° N	North	Along Lat. 15° N	Became unimportant on 27

**TABLE 6**  
**Details of the weather systems during July 2016**

S. No.	System	Duration	Place of initial location	Direction of movement	Place of Final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>(A) Deep Depression/Depression</b>						
1.	Land Depression	6 - 7 (0000 UTC)	Northeast Madhya Pradesh and neighbourhood (30 kms east of Satna)	Stationary	<i>In situ</i>	It weakened into a well mark low pressure area on 7. Details are given in the article on Storms & Depressions over the north Indian Ocean - 2016
<b>(B) Well marked Low/Low pressure area</b>						
1.	Low Pressure area	10 - 12	Jharkhand and adjoining areas of north Odisha	West	Central parts of north Madhya Pradesh	It formed under the influence of a cyclonic circulation extending between mid & upper tropospheric levels over Odisha and adjoining areas of Gangetic West Bengal and northwest Bay of Bengal. It became less marked on 13. However associated cyclonic circulation extending upto mid tropospheric levels persisted
2.	Do	31 Jul - 3 Aug	northeast and adjoining areas of northwest and east central Bay of Bengal	Do	Northeast Madhya Pradesh and neighbourhood	It formed under the influence of a cyclonic circulation extending between 1.5 & 5.8 kms a.s.l. over east central Bay of Bengal and neighbourhood. Became less marked on 4 August. However, associated cyclonic circulation extending upto mid tropospheric levels persisted during 31 July - 4 August and merged with the monsoon trough
<b>(C) Western Disturbances /Eastward moving Systems</b>						
<b>(i) Upper air cyclonic circulation</b>						
1.	Between 3.1 & 5.8 kms a.s.l.	6 - 8	North Pakistan and neighbourhood	Northeast	Eastern parts of Jammu & Kashmir and neighbourhood	Moved away east northeastwards the same evening of 8
2.	Do	9 - 10	Do	Do	Do	Moved away northeastwards on 11
3.	Upto mid tropospheric levels	17 - 18	Do	Do	Eastern parts of Jammu & Kashmir	Moved away east-northeastwards on 19. Initially it lay as a trough in mid tropospheric westerlies with its axis at 5.8 kms a.s.l. during 15-16
4.	Do	25 - 27	Do	Do	Jammu & Kashmir and neighbourhood	Moved away east-northeastwards on 28
5.	Do	28 - 30	Do	Do	Do	Moved away east-northeastwards on 31
<b>(ii) Trough in Westerlies</b>						
1.	Mid & upper tropospheric levels	11 - 13	Along Long. 65° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	East	Along Long. 72° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Moved away northeastwards on 14
2.	Upto Mid tropospheric levels	18 - 19	Along Long. 64° 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 northeastwards on 20
3.	Do	22 - 23	Along Long. 70° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 78° E to the north of Lat. 35° N (axis at 5.8 kms a.s.l.)	Moved away northeastwards on 24.
4.	Do	31 Jul – 2 Aug	Along Long. 65° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)		Along Long. 76° E to the north of Lat. 30° N	Moved away northeastwards on 3 August (axis at 5.8 kms a.s.l.)

TABLE 6 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>(iii) Induced cyclonic circulation</i>						
1.	At lower levels	22	Punjab and neighbourhood	Stationary	<i>In situ</i>	Became less marked on 23
<b>(D) Other upper air cyclonic circulations</b>						
1.	Between lower & mid tropospheric levels	1 - 5	Kutch and neighbourhood	Stationary	<i>In situ</i>	Became un-important on 6
2.	Upto mid tropospheric levels	2	West Uttar Pradesh and neighbourhood	Do	Do	Became less marked on 3
3.	Between lower & mid tropospheric levels	11	Odisha and adjoining Jharkhand	Do	Do	Merged with the low pressure area over central parts of Madhya Pradesh on 12
4.	Do	13	Kutch and neighbourhood	Do	Do	Became less marked on 14
5.	Upto mid tropospheric levels	13 - 18	Central Parts of Madhya Pradesh	North	West Uttar Pradesh and neighbourhood	Became less marked on 19. It was associated with the low pressure area (II (2)) during 10 to 12. Thereafter it lay embedded in the monsoon trough
6.	Do	14 - 15	Jharkhand and adjoining north Odisha	Do	Jharkhand and neighbourhood	It merged with the monsoon trough on 16
7.	Do	14 - 18	Northeast Arabian Sea and adjoining areas of Saurashtra	Stationary	<i>In situ</i>	Became un-important on 19
8.	Between 3.1 & 5.8 kms a.s.l.	15	Southwest Bay of Bengal and adjoining Sri-Lanka	Do	Do	Became less marked on 16
9.	Between 3.6 & 5.8 kms a.s.l.	16 - 18	East central Arabian Sea and adjoining areas of north Kerala and Karnataka	West	Lakshadweep area and neighbourhood	Became less marked on 19
10.	Do	18 - 22	Sub-Himalayan West Bengal & Sikkim	Do	Bihar and adjoining Sub-Himalayan West Bengal & Sikkim	Became less marked on 23
11.	Do	19	Rayalaseema and neighbourhood	Stationary	<i>In situ</i>	Became less marked on 20
12.	Do	20 - 22	West central Bay of Bengal off Andhra Pradesh coast	North	North coastal Andhra Pradesh and adjoining southwards with height on 21 & 22 south Odisha & west central Bay of Bengal	Became less marked on 23. It tilted southwards with height on 21 & 22 south Odisha & west central Bay of Bengal
13.	Between 0.9 & 3.6 kms a.s.l.	22 - 25	Chhattisgarh and adjoining areas of Vidarbha	Northwest	West Madhya Pradesh and adjoining east Rajasthan	Became less marked on 26
14.	Upto mid tropospheric levels	27 - 29	East Rajasthan and adjoining northwest Madhya Pradesh	Stationary	<i>In situ</i>	It merged with the cyclonic circulation over Haryana and adjoining areas of north Rajasthan and Punjab on 30
15.	Between lower & mid tropospheric levels	25 - 27	Marathwada and neighbourhood	Oscillatory	Marathwada and adjoining Madhya Maharashtra	Became less marked on 28
16.	Between 2.1 & 3.1 kms a.s.l.	27	South Madhya Pradesh and neighbourhood	Stationary	<i>In situ</i>	Became less marked on 28



TABLE 6 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
17.	At 5.8 kms a.s.l.	26	East central Arabian Sea off Karnataka coast	Do	Do	Became less marked on 27
18.	Upto mid tropospheric levels	28 - 30	Assam & Meghalaya and neighbourhood	East	East Assam and neighbourhood	Became less marked on 31
19.	Between 3.1 & 5.8 kms a.s.l.	28 - 30	south Gujarat and neighbourhood	North	North Gujarat and adjoining south Rajasthan	Became less marked on 31
20.	Upto mid tropospheric levels	29 Jul - 8 Aug	Haryana and neighbourhood	West-southwest	Southwest Rajasthan and neighbourhood	It associated with a low pressure area formed under its influence on 5 <sup>th</sup> evening See [Table 3 II(2)]
21.	Between 3.6 & 5.8 kms a.s.l.	29 - 30	Royalaseema and neighbourhood	West	Interior Karnataka and neighbourhood	Became less marked on 31
22.	Upto mid tropospheric levels	31 Jul - 2 Aug	Southwest Uttar Pradesh and neighbourhood	Do	Northwest Madhya Pradesh and neighbourhood	It merged with the monsoon trough on 3 August
<b>(E) North-south trough</b>						
1.	At lower levels	19 - 20	From the cyclonic circulation over Sub-Himalayan West Bengal & Sikkim to West central Bay of Bengal	Stationary	<i>In situ</i>	Became less marked on 21
2.	Do	26	Marathwada to south Tamil Nadu across north interior Karnataka and Royalaseema	Do	Do	Became less marked on 27
3.	Upto lower tropospheric levels	28	Marathwada to south Tamil Nadu	Do	Do	Became less marked on 29. A cyclonic circulation extending upto 2.1kms a.s.l. over north interior Karnataka and adjoining Marathwada on 28
4.	Upto mid tropospheric levels	31 Jul	From the cyclonic circulation over southwest Uttar Pradesh and neighbourhood	Do	Do	Became less marked on 1 Aug
<b>(E) East-West Shear Zone</b>						
1.	At 5.8 kms a.s.l.	11 - 13	Along Lat. 18° N	North	Along Lat. 22° N	Became less marked on 14
2.	Do	23 - 24	Along Lat. 15° N	Do	Along Lat. 17° N	Became less marked on 25
3.	Between mid & upper tropospheric levels	31	Along Lat. 14° N	Stationary	<i>In situ</i>	Became less marked on 1 Aug

third week of Aug. the western end shifted gradually towards normal and then south of its normal position with eastern end at near normal position, which shifted north of its normal position towards the end of August month.

With the beginning of September the west end of trough shifted close to the foothills of the Himalayas while the eastern end remained south of its normal position. Finally it became disorganized from 15<sup>th</sup> September.

### 5.3. Tibetan Anticyclone/High

This year, the Tibetan anticyclone was seen first to southeast of its normal position during the latter half of June month. Then it shifted to its near normal position except for last few days of third week of June when it was seen to west of its normal position which led to enhanced rainfall activity over the Western Himalayan Region. Thereafter, it was seen either in normal/near normal

TABLE 7

## Details of the weather systems during August 2016

S. No.	System	Duration	Place of initial location	Direction of movement	Place of Final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>(A) Depression/Deep Depression</b>						
1.	Deep Depression	9 - 12	Coastal areas of West Bengal and neighbourhood centred near Lat. 22.0° N/ Long. 88.5° E	Northeast-west	Jharkhand and neighbourhood centred near Lat. 24.2° N/ Long. 84.5° E	Details are given in the article on Storms & Depressions over the north Indian Ocean - 2016
2.	Do	16 (1200 UTC) - 20	Northwest Bay of Bengal and neighbourhood centred near Lat. 21.0° N/ Long. 89.0° E	West	East Rajasthan and adjoining northwest Madhya Pradesh centred near Lat. 24.8° N/ Long. 77.2° E	Details are given in the article on Storms & Depressions over the north Indian Ocean - 2016
<b>(B) Well marked Low/Low Pressure area</b>						
1.	Low pressure area	3 - 9	Northwest Bay of Bengal off Odisha coast	Northwest	East Rajasthan and adjoining west Madhya Pradesh	Became less marked on 10. Associated cyclonic circulation extended up to upper tropospheric levels
2.	Do	5 (1200 UTC) - 6	Kutch and neighbourhood	West	South Pakistan and adjoining southwest Rajasthan	It formed under the influence of a cyclonic circulation extending upto lower tropospheric levels over southwest Rajasthan and neighbourhood. It became less marked on 7. Associated cyclonic circulation extending upto mid tropospheric levels persisted on 7 and lay over south Pakistan and neighbourhood on 8 and became less marked on 9
3.	Well marked low pressure area	20 - 23	Northeast Myanmar and neighbourhood	Do	Northeast Madhya Pradesh and neighbourhood	Became less marked on 24. Associated cyclonic circulation extended upto mid tropospheric levels and tilted southwards with height
4.	Low pressure area	26 - 29	West central Bay of Bengal off north Andhra Pradesh coast	Do	West central Bay of Bengal and adjoining north coastal Andhra Pradesh	Initially it lay as an upper air cyclonic circulation between mid & upper air tropospheric levels over central parts of Bay of Bengal and neighbourhood on 24 and over west central Bay of Bengal off Andhra Pradesh coast on 25. Under its influenced, a low pressure area formed. Became less marked in the evening of 29. Associated cyclonic circulation extended upto mid tropospheric levels and tilted southwards with height during 26 -29
<b>(C) Western Disturbances /Eastward moving Systems</b>						
<b>(i) Upper air cyclonic circulation</b>						
<b>(ii) As a trough</b>						
1.	Upto Mid tropospheric levels	3 - 8	Along Long. 62° E to the north of Lat. 30° N (with its axis at 5.8 kms a.s.l.)	Northeast	Along Long. 75° E to the north of Lat. 32° N (with its axis at 5.8 kms a.s.l.)	Moved away east-northeastwards on 9
2.	Do	12 - 14	Along Long. 73° E to the north of Lat. 30° N (with its axis at 5.8 kms a.s.l.)	Do	Along Long. 76° E to the north of Lat. 35° N (with its axis at 5.8 kms a.s.l.)	Initially it lay as an upper air cyclonic circulation extending upto mid tropospheric levels over north Pakistan and neighbourhood during 9 - 11. A trough lay aloft with its axis at 5.8 kms a.s.l. on 10 & 11. Moved away northeastwards the same evening of 14

TABLE 7 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.	Do	13(1200 UTC) - 20	Along Long. 61° E to the north of Lat. 30° N (with its axis at 5.8 kms a.s.l.)	Do	Along Long. 73° E to the north of Lat. 30° N (with its axis at 5.8 kms a.s.l.)	Moved away east-northeastwards the same evening of 20
4.	Upto Mid tropospheric levels	20 - 24	Along Long. 64° E to the north of Lat. 28° N (with its axis at 5.8 kms a.s.l.)	Northeast	Along Long. 73° E to the north of Lat. 30° N (with its axis at 5.8 kms a.s.l.)	Moved away east-northeastwards on 25
5.	Do	24 - 28	Along Long. 63° E to the north of Lat. 28° N (with its axis at 5.8 kms a.s.l.)	Do	Along Long. 70° E to the north of Lat. 30° N (with its axis at 5.8 kms a.s.l.)	Moved away northeastwards on 29
6.	Mid & Upper tropospheric levels	29 Aug - 3 Sep	Along Long. 64° E to the north of Lat. 30° N (with its axis at 5.8 kms a.s.l.)	Do	Along Long. 74° E to the north of Lat. 30° N (with its axis at 5.8 kms a.s.l.)	Moved away northeastwards in the evening of 3 September
7.	Upto Mid tropospheric levels	3 - 8	Along Long. 62° E to the north of Lat. 30° N (with its axis at 5.8 kms a.s.l.)	Do	Along Long. 75° E to the north of Lat. 32° N (with its axis at 5.8 kms a.s.l.)	Moved away east-northeastwards on 9
<b>(D) Other upper air cyclonic circulations</b>						
1.	Between 3.1 & 5.8 kms a.s.l.	1 - 3	Gujarat Region and neighbourhood	West	South Pakistan and neighbourhood	Became less marked on 4
2.	Do	6	Jharkhand and adjoining north Odisha	Stationary	<i>In situ</i>	It merged with the monsoon trough on 7
3.	Do	11	East Rajasthan and adjoining west Madhya Pradesh	Do	Do	It merged with the cyclonic circulation over Haryana and adjoining areas of north Rajasthan and west Uttar Pradesh on 7
4.	Between mid & upper tropospheric levels	16	Jharkhand and neighbourhood	Do	Do	Became less marked on 17
5.	Upto lower tropospheric levels	17	West Uttar Pradesh and neighbourhood	Do	Do	Became less marked on 18
6.	Between 3.1 & 5.8 kms a.s.l.	18 - 19	Saurashtra & Kutch and neighbourhood	Do	Do	Became less marked on 20
7.	Upto upper tropospheric levels	24 - 28	Northwest Madhya Pradesh and adjoining east Rajasthan	West	South Pakistan and adjoining areas of Kutch	Became less marked on 29
8.	Upto mid tropospheric levels	24 - 26	Northeast Bay of Bengal and neighbourhood	Northwest	North Bay of Bengal and neighbourhood	Became less marked on 27
9.	Between 3.1 & 4.5 kms a.s.l.	26	Southeast Rajasthan and adjoining areas of Gujarat Region and southwest Madhya Pradesh	Stationary	<i>In situ</i>	Became less marked on 27
10.	Upto mid tropospheric levels	27 - 28	Eastern parts of Vidarbha and adjoining south Chhattisgarh	West	Marathwada and neighbourhood	Became less marked on 29
11.	Upto mid tropospheric levels	30 - 31	West central Bay of Bengal and adjoining north coastal Andhra Pradesh	Do	North coastal Andhra Pradesh and neighbourhood	Became less marked on 1 September

TABLE 7 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
12.	Between lower & mid tropospheric levels	28	South Gujarat and neighbourhood	Stationary	<i>In situ</i>	Became less marked on 29
13.	At lower levels	29	West Uttar Pradesh and neighbourhood	Do	Do	It merged with the above cyclonic circulation on 30
14.	Upto mid tropospheric levels	30 Aug - 2 Sep	West Rajasthan and neighbourhood	East	Punjab and neighbourhood	Became less marked on 3 September
15.	Between 4.5 & 5.8 kms a.s.l.	30	South Tamil Nadu and adjoining Comorin area	Stationary	<i>In situ</i>	Became less marked on 31
16.	At lower levels	31 Aug	East Uttar Pradesh and neighbourhood	Do	Do	Became less marked on 1 September
<b>(E) North-South trough/Other trough</b>						
1.	Upto mid tropospheric levels	30	From east Bihar to Gangetic West Bengal	Stationary	<i>In situ</i>	Became less marked on 3
<b>(F) East-West shear zone</b>						
1.	At upper tropospheric levels	2 - 7	Along Lat. 18° N	Oscillatory	Along Lat. 21° N	Became less marked on 8
2.	Between 4.5 & 5.8 kms a.s.l.	31 Aug	Along Lat. 11° N	Stationary	<i>In situ</i>	Became less marked on 1 September

position or wandering between west and north of its normal position but with weak intensity upto 1<sup>st</sup> August and disappeared on 2<sup>nd</sup> and re-developed the next day. It remained weak and to northwest of its normal position upto 10<sup>th</sup> August and then remained to northeast/east upto 30<sup>th</sup> August. On the last day of the Aug. month it regained its strength and position which lasted till first week of Sept. Then it gradually dissolved and was seen as a ridge thereafter roughly along Lat. 23° N - Lat. 28° N upto third week of Sept. It shifted south of its normal position and then southeastwards thus becoming un-important in the second week of October.

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

The STWJ started shifting northwards from the last week of May. Srinagar reported 71 knots wind (at 204 hPa) at 0000 UTC of 5<sup>th</sup> June. Subsequently, the core of STWJ shifted to the north of the Himalayas. However, it made occasional re-appearances along the latitude of Srinagar. In the first week of September, it once again shifted southwards as evidenced by the 68 knots westerly wind reported over Srinagar at 176 hPa on 25<sup>th</sup> September (0000 UTC).

#### 5.5. Tropical Easterly Jet (TEJ)

The TEJ got established over the southern tip of Peninsular India by 16<sup>th</sup> May with Thiruvananthapuram reporting easterlies of 75 kts at 113 hPa level. A wide latitudinal spread of the easterly jet speed winds

was observed during July, August and September (first fortnight) while during June and second fortnight of September; the stations over the Peninsular India only reported jet wind speeds. The highest wind speed of 126 kts at 154 hPa was reported at Guwahati on 19<sup>th</sup> July.

Apart from Thiruvananthapuram, Chennai, Aminidivi, Minicoy, Panjim, Mumbai and Port Blair, Jet speed winds were reported over Ahmedabad, Bhubaneswar, Mangalooru, Hyderabad, Jagdalpur, Jharsuguda, Kochi, Kolkata, Nagpur, Pune, Bhopal, Raipur, Machilipatnam, Karaikal and Visakhapatnam on several days during the season.

## 6. Other features

### 6.1. Monthly wind anomalies during southwest monsoon 2016

The monthwise circulation anomaly features at lower, middle & upper tropospheric levels viz., 850, 700, 500 & 200 hPa during the southwest Monsoon season are discussed below:

#### 6.1.1. June wind anomaly features

In the monthly wind pattern, two anomalous cyclonic circulations were seen at 850 hPa, one over West Central (WC) Arabian Sea off Andhra coast extending upto 700 hPa and second over NW Arabian Sea. A ridge at 200 hPa extended along 30° N.

TABLE 8

## Details of the weather systems during September 2016

S. No.	System	Duration	Place of initial location	Direction of movement	Place of Final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>(A) Well marked Low/Low Pressure area</b>						
1.	Low pressure area	4 - 8	Gangetic West Bengal and adjoining northwest Bay of Bengal	Northwest	Jharkhand and adjoining Gangetic West Bengal	It formed under the influence of a cyclonic circulation extending between mid & upper tropospheric levels over northwest Bay of Bengal and neighbourhood. Became less marked on 9. Associated cyclonic circulation persisted upto 11 and became less marked on 12
2.	Do	12 - 15	west central Bay of Bengal and adjoining areas of south Odisha and north coastal Andhra Pradesh	West	Telangana and neighbourhood	It formed under the influence of a cyclonic circulation extending upto mid tropospheric levels over west central and adjoining areas of northwest Bay of Bengal, coastal areas of Odisha and north coastal Andhra Pradesh. Became less marked on 16. Associated cyclonic circulation tilting southwards with height persisted upto 19 and became less marked on 20
3.	Well marked low pressure area	21 - 26	West central Bay of Bengal and adjoining areas of coastal Andhra Pradesh	Do	Vidarbha and adjoining areas of south Chhattisgarh and southeast Madhya Pradesh	It formed under the influence of a cyclonic circulation extending between mid & upper tropospheric levels over west central and northwest Bay of Bengal and adjoining coastal areas of south Odisha and north Andhra Pradesh. It was well marked during 22 - 24. Became less marked on 27. Associated cyclonic circulation extended upto upper tropospheric levels and tilted southwards with height
<b>(B) Western Disturbances /Eastward moving Systems</b>						
<i>(i) As a Trough in westerlies</i>						
1.	Upto mid tropospheric levels	6 - 8	Along Long. 72° E to the north of Lat. 25° N (axis at 5.8 kms a.s.l.)	Northeast	Along Long. 75° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	It lay aloft an upper air cyclonic circulation over north Pakistan and adjoining Afghanistan on 6. It moved northeastwards on 8 <sup>th</sup> evening
2.	Do	14	Along Long. 70° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Stationary	<i>In situ</i>	It moved away northeastwards on 15
3.	Do	15 - 17	Along Long. 64° E to the north of Lat. 25° N (axis at 5.8 kms a.s.l.)	Northeast	Along Long. 72° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	It moved away northeastwards on 18
4.	Do	17 - 18	Along Long. 85° E to the north of Lat. 25° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 86° E to the north of Lat. 23° N (axis at 5.8 kms a.s.l.)	Became less marked on 19
5.	Do	25 - 26	Along Long. 72° E to the north of Lat. 30° N (axis at 5.8 kms a.s.l.)	Do	Along Long. 72° E to the north of Lat. 32° N (axis at 5.8 kms a.s.l.)	Initially it lay as an upper air cyclonic circulation extending between 3.1 & 3.6 kms a.s.l. on 24 over north Pakistan and neighbourhood. It moved away northeastwards on 27
<i>(ii) As an upper air cyclonic circulation</i>						
1.	Upto mid tropospheric levels	6	North Pakistan and adjoining Afghanistan	Stationary	<i>In situ</i>	Became less marked on 7
2.	Upto mid tropospheric levels	11 - 14	North Pakistan and neighbourhood	East	Jammu & Kashmir and neighbourhood	Moved away northeastwards on 14



TABLE 8 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.	Between 3.1 & 5.8 kms a.s.l.	20 - 23	North Pakistan and adjoining Jammu & Kashmir	Northeast	Eastern parts of Jammu & Kashmir and neighbourhood	Initially it lay as a trough in mid tropospheric westerlies extended along Long. 55° E to the north of Lat. 32° N on 19. Moved away northeastwards on 24
<i>(iii) Other upper air cyclonic circulations</i>						
1.	Between 5.8 & 7.6 kms a.s.l.	1 - 3	Comorin - Maldives area	West	Maldives - Lakshadweep area	It became un-important on 4
2.	Between lower & mid tropospheric levels	1	Northwest Madhya Pradesh and adjoining east Rajasthan	Stationary	<i>In situ</i>	Became less marked on 2
3.	Upto mid tropospheric levels	6 - 9	Gujarat and neighbourhood	East	South Rajasthan and neighbourhood	Became less marked on 10
4.	Do	8 - 19	Northwest Bay of Bengal and adjoining Gangetic West Bengal	West	Southwest Madhya Pradesh and neighbourhood	Became less marked on 20. It was tilted southwards with height and associated with the low pressure area formed [I(1)] during 12-15
5.	Between 3.6 & 5.8 kms a.s.l.	8	West central Bay of Bengal and neighbourhood	Stationary	<i>In situ</i>	It merged with the cyclonic circulation over northwest Bay of Bengal and adjoining Odisha on 9
6.	Between lower & mid tropospheric levels	10 - 12	Kutch and adjoining south Pakistan	North	South Pakistan and adjoining southwest Rajasthan	Became less marked on 13
7.	Upto mid tropospheric levels	13 - 14	Central parts of Uttar Pradesh and neighbourhood	South	Southwest Uttar Pradesh and neighbourhood	Became less marked on 15
8.	Do	28 Sep - 5 Oct	Chhattisgarh and adjoining areas of Odisha and Jharkhand	West	Southeast Rajasthan and neighbourhood	Became less marked on 7 Oct
9.	At lower levels	15	West central Bay of Bengal off Andhra Pradesh coast	Stationary	<i>In situ</i>	Became less marked on 16
10.	Do	18 - 19	Assam & Meghalaya and neighbourhood	East	Manipur and neighbourhood	Became less marked on 20
11.	Between lower & mid tropospheric levels	19 - 20	South Gujarat Region and neighbourhood	West	Saurashtra & Kutch and neighbourhood	Became un-important on 21
12.	At lower levels	20	East Bihar and neighbourhood	Stationary	<i>In situ</i>	Became less marked on 21
13.	Upto lower tropospheric levels	21	Southwest Uttar Pradesh and neighbourhood	Do	Do	Became less marked on 22
14.	Do	21	East Uttar Pradesh and adjoining Bihar	Do	Do	Became less marked on 22
15.	Upto mid tropospheric levels	22 - 26	Gulf of Siam and neighbourhood	West	East central Bay of Bengal and neighbourhood	Became less marked on 27
16.	At lower levels	24	Tripura and neighbourhood	Stationary	<i>In situ</i>	Became less marked on 25
17.	Upto lower tropospheric levels	25 - 28	Sub-Himalayan West Bengal & Sikkim and neighbourhood	East	Tripura and neighbourhood	Became less marked on 29
18.	Do	26	East Assam and neighbourhood	Stationary	<i>In situ</i>	Became less marked on 27

TABLE 8 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
19.	Between 3.6 & 5.8 kms a.s.l.	27	Southeast and adjoining east central Bay of Bengal	Do	Do	Became less marked on 28
20.	Upto lower tropospheric levels	29 Sep - 1 Oct	Eastern parts of Nagaland & Manipur	Do	Do	Became less marked on 2 Oct
21.	Between 3.1 & 5.8 kms a.s.l.	29 Sep - 1 Oct	Gulf of Siam and neighbourhood	Do	Do	Became less marked on 2 Oct
22.	Between mid & upper tropospheric levels	30 Sep - 2 Oct	West central Bay of Bengal off north Andhra Pradesh coast	west	Telangana and adjoining north coastal Andhra Pradesh	Became less marked on 3 Oct
<b>(C) Other Troughs/North-south trough</b>						
1.	At lower levels	2 - 3	Sub-Himalayan West Bengal & Sikkim to northwest Bay of Bengal	Stationary	<i>In situ</i>	It merged with the low pressure area over Gangetic West Bengal and adjoining northwest Bay of Bengal on 4
2.	Do	22	From Punjab to east central Bay of Bengal across Haryana, east Rajasthan, west Madhya Pradesh, Vidarbha, Telangana & centre of well marked low pressure area	Do	Do	Became less marked on 23
3.	Mid tropospheric levels	26 - 29	From east Uttar Pradesh to Telangana across east Madhya Pradesh	Oscillatory	From east Uttar Pradesh to northeast Madhya Pradesh	Became less marked on 30
<b>(D) East-West shear zone/Wind discontinuity</b>						
1.	Between 3.1 & 5.8 kms a.s.l.	12 - 16	Along Lat. 16° N	North	Along Lat. 17° N	Became less marked on 17
2.	At mid tropospheric levels	29 Sep - 1 Oct	Along Lat. 18° N	South	Along Lat. 17° N	Became less marked on 2 Oct

In the week ending 8<sup>th</sup> June, an anomalous cyclonic circulation was seen at 850 hPa over Southeast (SE) Arabian Sea extending upto 500 hPa. At 700 hPa, an anomalous cyclonic circulation was seen at over Southwest (SW) Bay of Bengal off Tamil Nadu coast extending upto 500 hPa. Two anomalous anticyclonic circulations were seen at 700 hPa, one over Arunachal Pradesh and neighbourhood and second over Rajasthan and neighbourhood.

In the week ending 15<sup>th</sup> June, five anomalous cyclonic circulations were seen at 850 hPa, one over Rajasthan and neighbourhood, second over Assam Meghalaya extending upto 300 hPa, Third over West Central (WC) Bay of Bengal off Andhra coast extending upto 700 hPa, fourth over East Central (EC) Arabian Sea off Karnataka coast and fifth over SE Arabian Sea. A ridge at 200 hPa extended along 12° N.

In the week ending 22<sup>nd</sup> June, three anomalous cyclonic circulations were seen at 850 hPa, one over Rajasthan and neighbourhood, second over Vidarbha and

neighbourhood and third over Southwest (SW) Bay of Bengal off Tamil Nadu coast extending upto 500 hPa. A ridge at 200 hPa extended along 30° N.

In the week ending 29<sup>th</sup> June, two anomalous cyclonic circulations were seen at 850 hPa, one over East Central (EC) Arabian Sea off Maharashtra Coast extending upto 700 hPa and second over West Central (WC) Bay of Bengal off Andhra coast extending upto 200 hPa. A ridge at 200 hPa extended along 30° N.

#### 6.1.2. July wind anomaly features

In the monthly wind pattern, three anomalous cyclonic circulations were seen at 850 hPa, one over Vidarbha and neighbourhood extending upto 700 hPa, second over Haryana and neighbourhood and third over Tamil Nadu coast and neighbourhood extending upto 500 hPa. At 700 hPa, anomalous cyclonic circulation was seen over eastcentral (EC) Arabian Sea off Karnataka coast. A ridge at 200 hPa extended along 30° N.

In the week ending 6<sup>th</sup> July, two anomalous cyclonic circulations were seen at 850 hPa, one over Chhattisgarh and neighbourhood extending upto 700 hPa and second over Rajasthan and neighbourhood extending upto 700 hPa. At 700 hPa, two anomalous cyclonic circulation were seen, one over Gangetic West Bengal and neighbourhood extending upto 500 hPa and second over Northeast (NE) Arabian sea off Gujarat coast.

In the week ending 13<sup>th</sup> July, two anomalous cyclonic circulations were seen at 850 hPa, one over Rajasthan and neighbourhood and second over Chhattisgarh and neighbourhood extending upto 500 hPa. A ridge at 200 hPa extended along 29° N.

In the week ending 20<sup>th</sup> July, an anomalous cyclonic circulation was seen at 850 hPa over Vidarbha and neighbourhood. A ridge at 200 hPa extended along 30° N.

In the week ending 27<sup>th</sup> July, two anomalous cyclonic circulations were seen at 850 hPa, one over Punjab and neighbourhood and second over Southwest Bay of Bengal off Sri - Lanka coast. A ridge at 200 hPa extended along 25° N.

In the week ending 3<sup>rd</sup> August, an anomalous cyclonic circulation was seen at 850 hPa over Vidarbha and neighbourhood extending upto 300 hPa. At 700 hPa, three anomalous cyclonic circulation were seen, one over Northwest (NW) Bay of Bengal off Gangetic West Bengal coast extending upto 300 hPa, second over West Madhya Pradesh and neighbourhood and third over West Madhya Pradesh and adjoining East Rajasthan extending upto 300 hPa.

### 6.1.3 August wind anomaly features

In the monthly wind pattern, four anomalous cyclonic circulations were seen at 850 hPa, one over NMMT and neighbourhood extending upto 500 hPa, second over Orissa and neighbourhood, third over Madhya Pradesh and neighbourhood extending upto 300 hPa and fourth over Southwest (SW) Bay of Bengal off Tamil Nadu Coast extending upto 500 hPa. An anomalous anticyclonic circulation was seen at 700 hPa over Interior Karnataka extending upto 500 hPa.

In the week ending 3<sup>rd</sup> August, an anomalous cyclonic circulation was seen at 850 hPa, over Vidarbha and neighbourhood extending upto 300 hPa. At 700 hPa, two anomalous cyclonic circulations were seen, one over Northwest (NW) Bay of Bengal off Orissa coast extending upto 300 hPa & second over Rajasthan & neighbourhood.

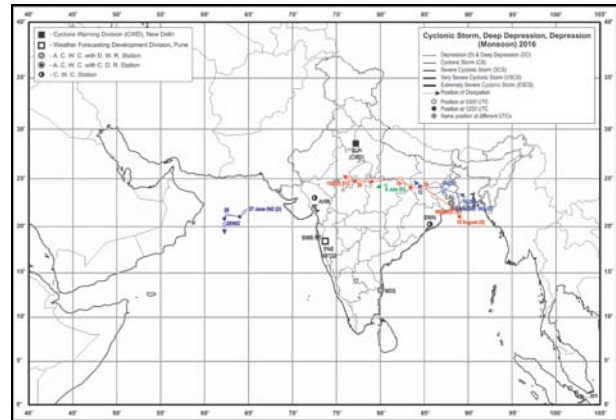


Fig. 8. Tracks of the intense low pressure systems during SW Monsoon 2016

In the week ending 10<sup>th</sup> August, two anomalous cyclonic circulations were seen at 850 hPa, one over Northeast (NE) Bay of Bengal extending upto 300 hPa and second over West Madhya Pradesh & neighbourhood extending upto 700 hPa. At 700 hPa an anomalous cyclonic circulation was seen over Northeast (NE) Arabian Sea off Gujarat coast extending upto 300 hPa.

In the week ending 17<sup>th</sup> August, an anomalous cyclonic circulation was seen at 850 hPa over NMMT and neighbourhood extending upto 500 hPa.

In the week ending 24<sup>th</sup> August, three anomalous cyclonic circulations was seen at 850 hPa one over Southeast (SE) Arabian sea off Kerala coast, second over Southwest (SW) Bay of Bengal off Tamil Nadu coast extending upto 700 hPa and third over Madhya Pradesh and neighbourhood extending upto 500 hPa. Two anomalous anticyclonic circulations over 850 hPa, one over Madhya Maharashtra extending upto 700 hPa and second over Westcentral (WC) Bay of Bengal extending upto 500 hPa. A ridgeat 200 hPa extended along 37° N.

In the week ending 31<sup>st</sup> August, an anomalous cyclonic circulation was seen at 850 hPa over Southwest (SW) Bay of Bengal off Tamil Nadu coast extending upto 500 hPa. An anomalous anticyclonic circulation was seen at 850 hPa over Gangetic West Bengal and neighbourhood extending upto 500 hPa.

### 6.1.4. September wind anomaly features

In the monthly wind pattern, two anomalous cyclonic circulations were seen at 850 hPa, one over Andhra coast and neighbourhood extending upto 500 hPa and second over Arunachal Pradesh and neighbourhood extending upto 700 hPa. At 500 hPa, anomalous cyclonic circulation was seen over Gujarat and neighbourhood.

In the week ending 7<sup>th</sup> September, an anomalous cyclonic circulation was seen at 700 hPa over Marathwada and neighbourhood. A ridge at 200 hPa extended along 25° N.

In the week ending 14<sup>th</sup> September, an anomalous cyclonic circulation was seen at 850 hPa over Andhra coast and neighbourhood extending upto 500 hPa. A ridge at 200 hPa extended along 25° N.

In the week ending 21<sup>st</sup> September, two anomalous cyclonic circulations were seen at 850 hPa over, one over Andhra coast and neighbourhood extending upto 500 hPa level and second over Marathwada and neighbourhood. At 700 hPa, an anomalous cyclonic circulation was seen over Madhya Pradesh and neighbourhood. A ridge at 200 hPa extended along 25° N.

In the week ending 28<sup>th</sup> September, an anomalous cyclonic circulation was seen at 850 hPa over Andhra Pradesh and neighbourhood extending upto 300 hPa.

In the week ending 5<sup>th</sup> October, an anomalous cyclonic circulation was seen at 850 hPa over Vidarbha.

## 7. Disastrous weather events and damage during monsoon months

### 7.1. June

According to media reports, Tamil Nadu & Kerala and Konkan & Goa witnessed the flood situations in the first and towards the last week of the month respectively. Heavy rain led to flash floods in low-lying areas of Malappuram district of Kerala state leading to collapse of a school building whereas flooding in Kanyakumari district in Tamil Nadu claimed 2 lives. Incessant heavy rain for couple of days led to flooding of low lying areas of Ratnagiri in Konkan & Goa. Trees and poles were uprooted and around 250 houses were damaged. Rain related incidents claimed 15 lives in Uttar Pradesh, 5 in Maharashtra and 2 in Himachal Pradesh. Thunderstorm/lightning accompanied by heavy rains over Bihar, Jharkhand, Uttar Pradesh and Madhya Pradesh claimed 90 lives. Similarly, it claimed 30 lives in Maharashtra, 18 in Odisha, 4 in Karnataka, 2 each in Andhra Pradesh and Telangana and 1 each in Uttarakhand and Rajasthan. Squall over Bengaluru city on 27<sup>th</sup> June caused felling of around 30 trees and killed 2 people.

### 7.2. July

According to media reports, Heavy rains, floods/flash floods and landslides incidents took a toll of

234 lives (72 in Uttarakhand, 65 in Madhya Pradesh, 42 in Assam & Meghalaya, 32 in Bihar, 21 in Maharashtra, 10 in Arunachal Pradesh, 8 in Uttar Pradesh, 5 in Rajasthan, 3 in Tamil Nadu and 2 in Himachal Pradesh). Thunderstorm/Lightning claimed 41 lives in Odisha, 3 in Uttar Pradesh and 1 each in Maharashtra and Telangana.

Incessant heavy rain led to floods and landslide across many parts of India during the July month. In the first wave of flood in Assam, Brahmaputra and its several tributaries were flooded affecting around 2 lakh people across 267 villages of 7 districts. Several embankments, roads, culverts, bridges and houses were damaged during initial half of July month. Similarly, around the same period incessant rain triggered floods in Rajasthan Bihar, Maharashtra and Madhya Pradesh. River Chambal was overflowing in Dholpur district affecting around 50 villages of southeast Rajasthan. In Bihar, floods in Mahananda and Kosi River inundated low lying areas and affected 50,000 people across 31 villages of 2 districts. Floods in river Peankota, Bande Vainganga in Vidarbha; Tapi, Godavari, Aasana, Mandvi and Panchganga in Madhya Maharashtra; Vashisthi in Konkan inundated low lying areas and damaged partially/temporarily around 3000 houses. Incessant heavy rain triggered severe floods in various parts of Madhya Pradesh. Floods in rivers Tapti, Narmada, Betwa, Shipra, Kalisindh, Palakmati and Machna affected 3.6 lakh people across 23 districts. It damaged around 2500 houses permanently and 37000 partially. Human casualties and livestock death were also reported. In Uttarakhand, series of cloudburst as per media were reported in Singholi, Pathakot, Oglia and Thal villages of Pithoragarh and Chamoli districts. It led to landslide and flashfloods in rivulets and claimed 49 lives and 594 livestock. Houses in around 1500 were fully/partially damaged.

During second half of July, floods occurred over eastern parts of India. Heavy incessant rain in catchment areas of Arunachal Pradesh and Bhutan caused second wave of floods in Assam. Over flowing of Brahmaputra and its tributaries caused severe floods in 28 districts of Assam. Nearly 30 lakh people in 3300 villages were affected and claimed around 25 human lives. Large scale erosion of land with inundation of low lying areas and dwellings, breach of several embankments and snapping of road transport and communication systems were reported. Around 2.3 lakh hectares of crop areas were damaged. Kaziranga National Park, Pobitora wildlife sanctuary and Saikhowa National Park were also affected. Floods were also reported from Arunachal Pradesh with overflow of Noa-Dehing, Jengthu, Lohit, Kamlang, Berrang, Siang and Tengapani rivers causing damage to cultivated lands, Paddy fields, Tea Gardens, Horticulture fields and livestock. Heavy rain in catchment areas of

Nepal led to flooding of Mahananda, Bakhra, Parmar, Kosi, Bagmati, and Ghagra rivers, it affected around 27 lakh people and 3.39 lakh hectares of crops across 12 districts. Towards the end of July month, overflowing of Ganga and Fullara River in West Bengal inundated low lands of 31 villages affecting 22,000 people in Malda district.

### 7.3. August

Floods/flash floods and landslides took a toll of 268 lives (160 in Bihar, 4 in West Bengal, 34 in Assam, 11 in Uttar Pradesh, 7 in Rajasthan, 2 in Himachal Pradesh, 17 in east Madhya Pradesh, 22 in Konkan & Goa 5 each in Jammu & Kashmir & Gujarat State and 1 in Uttarakhand). Rain related incidents claimed 12 lives in Maharashtra, 7 in Telangana, 4 in Jharkhand and 1 in Uttarakhand.

Incessant heavy rains in mid August led to flooding of river Retam, Chambal, Shivna, Kshipra, Son, Ken, Tamas and Betwa in Madhya Pradesh affecting normal life across 7 districts. Heavy rain in third week of Aug. caused floods in southeast Rajasthan affecting 50 villages across 6 districts. Overflowing of Chambal River submerged bridges, roads and crippled communication systems. During the third week, release of water from Nepal, Madhya Pradesh and Jharkhand triggered severe floods in Bihar. Sone, Punpun, Burhi-Gandak, Ghagra, Kosi overflowing rivers in Bihar inundated low lying areas and affected 41.9 lakh people across 2179 villages of 12 districts. During last week of Aug. release of water from Nepal and adjoining states of Madhya Pradesh and Uttarakhand led to rise in water level of major rivers Ganga, Mandakini, Yamuna, Betwa, Sharda and Ken in Uttar Pradesh affected 8.7 lakh people from 100 villages across 28 districts. Similarly release of water from Damodar Water Corporation and flooding of river Ganga inundated 45 villages of 6 districts and damaged around 150 houses in West Bengal.

### 7.4. September

According to media reports, heavy rains and floods/flashfloods took a toll of 35 people (10 in Andhra Pradesh, 4 each in Maharashtra and Telangana, 7 in Bihar and 5 each in Karnataka and Kerala). Thunderstorm/lightning claimed 9 lives in Madhya Pradesh, 8 each in Uttar Pradesh and Maharashtra and 1 each in Telangana and Tamil Nadu.

Heavy rain in upper catchment area of Jharkhand and release of water caused floods in the downstream areas.

#### Acknowledgment

The inputs from the offices of India Meteorological Department viz., (1) Director General of Meteorology

(Hydromet), New Delhi and (2) Additional Director General of Meteorology (Research), Pune are gratefully acknowledged. Thanks are due to Smt. J. C. Natu, Met. 'B' and Padma Kulkarni, S. A. for their help in bringing out this summary.

## Appendix

### Definitions of the terms given in '*Italics*'

#### Snowfall

<i>Light Snowfall</i>	- 10.4 cm or less
<i>Moderate Snowfall</i>	- 10.5 to 64.4 cm
<i>Heavy</i>	- 64.5 cm to 115.5 cm
<i>Very heavy</i>	- 115.6 to 204.4 cm
<i>Extremely heavy</i>	- $\geq 204.5$ cm

#### Rainfall

<i>Very light</i>	- 0.1 to 2.4 mm
<i>Light</i>	- 2.5 to 15.5 mm
<i>Moderate</i>	- 15.6 to 64.4 mm
<i>Heavy</i>	- 64.5 to 115.5 mm
<i>Very heavy</i>	- 115.6 to 204.4 mm
<i>Extremely Heavy</i>	- $\geq 204.5$ mm
<i>Large Excess</i>	- Percentage departure from normal rainfall is + 60% or more
<i>Excess</i>	- <i>Percentage departure from normal rainfall is + 20% to + 59%</i>
<i>Normal</i>	- Percentage departure from normal rainfall is from + 19 % to - 19 %
<i>Deficient</i>	- percentage departure from normal rainfall is from - 20 % to - 59 %
<i>Large Deficient</i>	- Percentage departure from normal rainfall is from - 60 % or less
<i>No rain</i>	- -100%

#### Monsoon activity

Active	- Average rainfall of a sub-division is more than 1½ to 4 times the normal with minimum 5 cms along the west coast and 3 cms elsewhere in at least two stations in the sub-division
Vigorous	- Average rainfall of a sub-division is more than 4 times or more than the normal with minimum 7 cm along the west coast and 5 cm elsewhere in at least two stations in the sub-division