Weather in India

POST MONSOON SEASON (October - December 2018)

1. Introduction

Post monsoon season-2018 was cyclogenetically a unique season, when four intense low pressure systems formed during period 1\textsuperscript{st} October - 31\textsuperscript{st} December. Out of these, three were Very Severe Cyclonic Storms (VSCSs) and the remaining one, a Severe Cyclonic Storms (SCS). No other Depression or Deep Depression formed in the season. Secondly, in a rarest of rare occurrence, two VSCS, one each in Bay of Bengal (Titli 7-13 October) and Arabian Sea (Luban 6-14 October) developed, simultaneously. This rare event occurred after 41 years. Also, Luban was the third cyclonic storm to cross Arabia and African coasts in 2018, against 8 such cyclones during the entire satellite era (1961-2018).

The southwest monsoon withdrew from the entire country on 21\textsuperscript{st} October and the northeast monsoon (NEM) rains commenced over the south peninsula on 1\textsuperscript{st} November against normal date of 20\textsuperscript{th} October and ceased on 2\textsuperscript{nd} January.

Rainfall over the core region of south peninsula during the season was below normal (66\% of LPA value), which was the 6\textsuperscript{th} lowest season since 1901. Northeast monsoon in the core region was, normal* in Kerala, deficient in Tamil Nadu, South interior Karnataka and Coastal Andhra Pradesh and large deficient over Rayalaseema.

The maximum temperatures were normal or above normal over major parts of the country during the season. The Minimum Temperatures were in general normal or below normal on most days.

Severe cold wave / cold wave conditions manifested over parts of Central and Northwest India towards the third week of December. They spread over northwest as well as central India and parts of peninsular India at the end of season.

Dense Fog prevailed over some parts of northern plains and at isolated pockets over south Peninsula especially over Tamil Nadu from last week of November and were more widespread during the month of December.

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

2. Seasonal rainfall (October-December)

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

During the season, rainfall over the country (56\% of LPA) over the four broad geographical regions was below normal, with East and Northeast India having the largest

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†Compiled by: A. Kashyapi, P. R. Abhang, J. C. Natu and P. N. Chopade, Weather Monitoring Unit, Pune – 411 005, India

*(853)
disparity at 48% followed by Central India at 50%. Northwest India at 44% deficit had only one subdivision with normal rainfall, (Jammu and Kashmir precipitation 98% of LPA). South Peninsula received precipitation 63% of LPA i.e., deficit by 37% of LPA. In this region, NE Monsoon being the chief rainy season remained deficient in all the three months affecting adversely the rabi crops yield. In the post monsoon season, out of 36 meteorological subdivisions, 18 subdivisions were large deficient, 13 deficient, 3 normal and remaining 2 subdivisions (Andaman & Nicobar Islands and Odisha) received excess rainfall.

The monthly rainfall for the country was normal during December (88% of its LPA) and deficient in October and November with 44% and 71% of its LPA, respectively.

Perturbations in the mid-latitude westerlies moved across the northern parts of the country and gave rain/snow in the higher reaches of Himalayas during most parts of the season; which did not result in much precipitation over the northwestern parts of the country except a few days in November. Global parameters like ENSO and IOD were neutral and MJO was favorable in phase 2-4 with amplitude >1 only on 26 days during the season.

3. Monthly features

3.1. October

3.1.1. Withdrawal of southwest monsoon

With the changeover of the lower tropospheric circulation pattern from cyclonic to anticyclonic, reduction of humidity in the lower tropospheric levels and dry weather prevailing over many parts of west and northwest India, southwest monsoon started its withdrawal from 29th September onwards. Initially it withdrew from some parts of Rajasthan, Kutch and north Arabian Sea, from remaining parts of Rajasthan, entire Jammu & Kashmir, Punjab, Haryana, Chandigarh and Delhi, Himachal Pradesh, Uttarakhand, west Uttar Pradesh, some parts of east Uttar Pradesh, west and east Madhya Pradesh and some more parts of Gujarat State and north Arabian Sea by 1st October. Further withdrawal was rapid and by 6th October the monsoon had withdrawn from all India other than Southern Peninsular region. The southwest monsoon withdrew from entire country on 21st October, with the setting in of the northeasterly and easterly winds in lower tropospheric levels over the Indian region.
### Table 1
Sub-division wise rainfall (mm) for each month and season as a whole (October-December, 2018)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Meteorological Sub-divisions</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual (mm)</td>
<td>Normal (mm)</td>
<td>Dep. (%)</td>
<td>Actual (mm)</td>
<td>Normal (mm)</td>
</tr>
<tr>
<td>1.</td>
<td>A &amp; N. Islands</td>
<td>298.9</td>
<td>296.7</td>
<td>1%</td>
<td>239.6</td>
</tr>
<tr>
<td></td>
<td>2. Arunachal Pradesh</td>
<td>57.6</td>
<td>183.0</td>
<td>-69%</td>
<td>60.6</td>
</tr>
<tr>
<td></td>
<td>3. Assam &amp; Meghalaya</td>
<td>46.8</td>
<td>154.8</td>
<td>-70%</td>
<td>16.9</td>
</tr>
<tr>
<td></td>
<td>4. Naga., Mani., Mizoram &amp; Tripura</td>
<td>88.7</td>
<td>179.8</td>
<td>-51%</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>5. Sub-Himalayan West Bengal &amp; Sikkim</td>
<td>72.3</td>
<td>154.2</td>
<td>-53%</td>
<td>11.2</td>
</tr>
<tr>
<td></td>
<td>6. Gangetic West Bengal</td>
<td>67.2</td>
<td>129.3</td>
<td>-48%</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>7. Orissa</td>
<td>120.3</td>
<td>111.6</td>
<td>8%</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>8. Jharkhand</td>
<td>23.1</td>
<td>75.2</td>
<td>-69%</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>9. Bihar</td>
<td>17.5</td>
<td>64.8</td>
<td>-73%</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>10. East Uttar Pradesh</td>
<td>0.3</td>
<td>49.2</td>
<td>-99%</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>11. West Uttar Pradesh</td>
<td>6.6</td>
<td>42.1</td>
<td>-84%</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>12. Uttarakhand</td>
<td>3.3</td>
<td>58.6</td>
<td>-94%</td>
<td>20.2</td>
</tr>
<tr>
<td></td>
<td>13. Haryana, Chandigarh &amp; Delhi</td>
<td>3.0</td>
<td>17.6</td>
<td>-83%</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>14. Punjab</td>
<td>4.2</td>
<td>22.0</td>
<td>-81%</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>15. Himachal Pradesh</td>
<td>11.6</td>
<td>42.5</td>
<td>-73%</td>
<td>37.3</td>
</tr>
<tr>
<td></td>
<td>16. Jammu &amp; Kashmir</td>
<td>22.0</td>
<td>38.9</td>
<td>-43%</td>
<td>77.6</td>
</tr>
<tr>
<td></td>
<td>17. West Rajasthan</td>
<td>0.4</td>
<td>5.4</td>
<td>-93%</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>18. East Rajasthan</td>
<td>1.2</td>
<td>16.9</td>
<td>-93%</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>19. West Madhya Pradesh</td>
<td>1.4</td>
<td>34.4</td>
<td>-96%</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>20. East Madhya Pradesh</td>
<td>1.5</td>
<td>37.5</td>
<td>-96%</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>21. Gujarat Region</td>
<td>0.5</td>
<td>23.4</td>
<td>-98%</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>22. Saurashtra &amp; Kutch</td>
<td>0.9</td>
<td>18.1</td>
<td>-95%</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>23. Konkan &amp; Goa</td>
<td>50.3</td>
<td>120.8</td>
<td>-58%</td>
<td>14.9</td>
</tr>
<tr>
<td></td>
<td>24. Madhya Maharashtra</td>
<td>20.1</td>
<td>79.0</td>
<td>-75%</td>
<td>19.6</td>
</tr>
<tr>
<td></td>
<td>25. Marathwada</td>
<td>9.2</td>
<td>72.3</td>
<td>-87%</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>26. Vidarbha</td>
<td>0.0</td>
<td>59.6</td>
<td>-99%</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>27. Chhattisgarh</td>
<td>4.1</td>
<td>63.3</td>
<td>-94%</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>28. Coastal Andhra Pradesh</td>
<td>48.4</td>
<td>193.2</td>
<td>-75%</td>
<td>41.8</td>
</tr>
<tr>
<td></td>
<td>29. Telangana</td>
<td>17.1</td>
<td>91.3</td>
<td>-81%</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>30. Rayalaseema</td>
<td>44.8</td>
<td>129.4</td>
<td>-65%</td>
<td>34.4</td>
</tr>
<tr>
<td></td>
<td>31. Tamil Nadu</td>
<td>157.7</td>
<td>180.2</td>
<td>-12%</td>
<td>156.8</td>
</tr>
<tr>
<td></td>
<td>32. Coastal Karnataka</td>
<td>150.2</td>
<td>189.5</td>
<td>-21%</td>
<td>20.3</td>
</tr>
<tr>
<td></td>
<td>33. North Interior Karnataka</td>
<td>39.9</td>
<td>112.0</td>
<td>-64%</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>34. South Interior Karnataka</td>
<td>97.6</td>
<td>147.7</td>
<td>-34%</td>
<td>18.9</td>
</tr>
<tr>
<td></td>
<td>35. Kerala</td>
<td>305.4</td>
<td>292.3</td>
<td>4%</td>
<td>131.4</td>
</tr>
<tr>
<td></td>
<td>36. Lakshadweep</td>
<td>152.9</td>
<td>157.1</td>
<td>-3%</td>
<td>96.7</td>
</tr>
</tbody>
</table>
TABLE 2
Details of the weather systems during October 2018

<table>
<thead>
<tr>
<th>S. No.</th>
<th>System</th>
<th>Duration</th>
<th>Place of initial Location</th>
<th>Direction of movement</th>
<th>Place of final location</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>Cyclonic storm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Very Severe Cyclonic Storm ‘TITLI’</td>
<td>8-13</td>
<td>Eastcentral Bay of Bengal</td>
<td>Northeast</td>
<td>Odisha</td>
<td>It weakened into a depression on 12 and into a low pressure on 13, the associated cyclonic circulation extended up to 0.9 km a.s.l. and became less marked on 14. Details are given in the article on Storms &amp; Depressions over the north Indian Ocean-2018.</td>
</tr>
<tr>
<td>2.</td>
<td>Very Severe Cyclonic Storm ‘LUBAN’</td>
<td>6-14</td>
<td>Southeast and adjoining east central Arabian Sea</td>
<td>East northeast</td>
<td>Yemen</td>
<td>It weakened into a well-marked low pressure area on 15. Became unimportant for Indian Region.</td>
</tr>
<tr>
<td>(B)</td>
<td>Well marked Low Pressure area/Low Pressure area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Low Pressure</td>
<td>20-22</td>
<td>Gulf of Thailand and neighbourhood</td>
<td>Northwest</td>
<td>Southern parts of Myanmar and neighbourhood</td>
<td>Under the influence of the cyclonic circulation over Gulf of Thailand &amp; neighbourhood the Low pressure formed on 20 and became unimportant for the region on 23.</td>
</tr>
<tr>
<td>(C)</td>
<td>Western Disturbances /Eastward moving systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Upper air cyclonic circulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Upto 5.8 kms a.s.l.</td>
<td>4-6</td>
<td>Northeast Afghanistan &amp; neighbourhood</td>
<td>Do</td>
<td>Northeast parts of Jammu &amp; Kashmir and neighbourhood</td>
<td>Moved away east-northeastwards.</td>
</tr>
<tr>
<td>4.</td>
<td>At 3.1 km a.s.l.</td>
<td>15-19</td>
<td>North Pakistan and neighbourhood</td>
<td>Do</td>
<td>Northeast Jammu &amp; Kashmir and neighbourhood</td>
<td>Initially it lay as a trough in the upper tropospheric westerlies and ran roughly along Long. 66° E to the north of Lat. 30° N on 14. A trough aloft at 3.1 km a.s.l. with its axis at 5.8 kms a.s.l. roughly along Long. 66° E to the north of 28° N from 15-18. Moved away east-northeastwards.</td>
</tr>
<tr>
<td>5.</td>
<td>Do</td>
<td>22</td>
<td>Northeast Afghanistan &amp; adjoining Pakistan</td>
<td>Stationary</td>
<td>In situ</td>
<td>It was seen as a trough with its axis at 5.8 kms a.s.l. roughly along 75° E to the north of 32° N on 23. It became less marked on 24.</td>
</tr>
<tr>
<td>7.</td>
<td>Between 3.1 &amp; 5.8 kms a.s.l.</td>
<td>29-31</td>
<td>Northeast Afghanistan &amp; neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Moved away Northeastwards.</td>
</tr>
<tr>
<td>8.</td>
<td>At 3.1 km a.s.l.</td>
<td>30 Oct-4 Nov</td>
<td>Western parts of Iran and neighbourhood</td>
<td>Do</td>
<td>Jammu and neighbourhood</td>
<td>A trough aloft with its axis at 5.8 km above m.s.l. roughly along Long. 54° E to the north of Lat. 28° N on 30, it moved away east-northeastwards on 5 November. The cyclone became less marked on 4 November.</td>
</tr>
</tbody>
</table>
### TABLE 2 (Contd.)

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ii) <em>As a trough</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>At 5.8 km a.s.l.</td>
<td>12</td>
<td>Along Long. 65.0° E to the north of Lat. 27.0° N</td>
<td>East</td>
<td>Eastern parts</td>
<td>Moved away eastwards</td>
</tr>
<tr>
<td>2.</td>
<td>Do</td>
<td>18-20</td>
<td>Along Long. 65° E to the north of Lat. 32° N</td>
<td>East northeast wards</td>
<td>Roughly along Long. 69° E to the north of Lat. 32° N</td>
<td>It was seen as a cyclonic circulation over Punjab and adjoining central Pakistan at 3.1 km a.s.l. on 21. Became less marked on 22</td>
</tr>
<tr>
<td>3.</td>
<td>At 7.6 km a.s.l.</td>
<td>29-31</td>
<td>Along Long. 82° E to the north of Lat. 20° N</td>
<td>Northeast</td>
<td>Roughly along Long. 86° E to the north of Lat. 26° N</td>
<td>Became less marked on 1 November</td>
</tr>
<tr>
<td>(iii) <em>As an Induced cyclonic circulation</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>5-11</td>
<td>Northwest Rajasthan and neighbourhood</td>
<td>Oscillatory</td>
<td>Haryana and neighbourhood</td>
<td>Became less marked on 12</td>
</tr>
<tr>
<td>2.</td>
<td>Upto 1.5 km a.s.l.</td>
<td>12</td>
<td>Pakistan and adjoining</td>
<td>Stationary</td>
<td><em>In situ</em></td>
<td>Became less marked on 13</td>
</tr>
<tr>
<td>3.</td>
<td>Do</td>
<td>14-18</td>
<td>Central Pakistan</td>
<td>Northeast</td>
<td>South Haryana and neighbourhood</td>
<td>Became less marked on 19</td>
</tr>
<tr>
<td>(D) <em>Other upper air cyclonic circulations</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>2-6</td>
<td>Southwest Bay of Bengal and adjoining Sri Lanka off Tamil Nadu coast</td>
<td>Stationary</td>
<td><em>In situ</em></td>
<td>Initially it lay as a trough in easterlies extending upto 1.5 km a.s.l. over southeast Bay of Bengal &amp; neighbourhood on 1 October. It became less marked on 6</td>
</tr>
<tr>
<td>2.</td>
<td>Upto 2.1 km a.s.l.</td>
<td>4-7</td>
<td>Northern parts of Bangladesh and adjoining West Bengal</td>
<td>East</td>
<td>Central parts of Assam and neighbourhood</td>
<td>Initially it lay as a trough from east Bihar to central parts of Bangladesh and extended between 1.5 &amp; 2.1 km a.s.l. across Sub-Himalayan West Bengal on 1 October. It became less marked on 8</td>
</tr>
<tr>
<td>3.</td>
<td>Upto 0.9 kms a.s.l.</td>
<td>4</td>
<td>South Kerala and adjoining interior Tamil Nadu</td>
<td>Stationary</td>
<td><em>In situ</em></td>
<td>Became less marked on 5</td>
</tr>
<tr>
<td>4.</td>
<td>Between 3.6 and 4.5 kms a.s.l.</td>
<td>12</td>
<td>Tamil Nadu and adjoining southwest Bay of Bengal between 3.6 to 4.5 kms a.s.l.</td>
<td>North</td>
<td>East central Arabian Sea off Karnataka coast</td>
<td>Became less marked on 13</td>
</tr>
<tr>
<td>5.</td>
<td>Between 1.5 and 4.5 km a.s.l.</td>
<td>13-14</td>
<td>Lakshadweep area and adjoining southeast Arabian Sea</td>
<td>Stationary</td>
<td><em>In situ</em></td>
<td>Became less marked on 15</td>
</tr>
<tr>
<td>6.</td>
<td>Upto 1.5 km a.s.l.</td>
<td>13-16</td>
<td>Coastal Karnataka and adjoining Goa</td>
<td>North</td>
<td>South Madhya Pradesh and adjoining</td>
<td>Became less marked on 17</td>
</tr>
<tr>
<td>7.</td>
<td>Upto 1.5 kms a.s.l.</td>
<td>14-17</td>
<td>Central Assam</td>
<td>East</td>
<td>East Assam and adjoining</td>
<td>Became less marked on 18</td>
</tr>
<tr>
<td>8.</td>
<td>Between 1.5 and 3.1 km a.s.l.</td>
<td>14-15</td>
<td>South Tamil Nadu and neighbourhood</td>
<td>Stationary</td>
<td><em>In situ</em></td>
<td>A Trough ran from the cyclonic circulation to north interior Karnataka at 1.5 km a.s.l. on 15. Became less marked on 16</td>
</tr>
<tr>
<td>9.</td>
<td>Upto 1.5 km a.s.l.</td>
<td>14</td>
<td>Southwest Rajasthan and adjoining Gujarat</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 15</td>
</tr>
<tr>
<td>10.</td>
<td>Upto 5.8 km a.s.l.</td>
<td>15-22</td>
<td>Gulf of Siam</td>
<td>West</td>
<td>Sri Lanka &amp; adjoining</td>
<td>It was seen as an east west trough roughly along Lat. 8.0° N and extended upto 3.1 kms a.m.s.l. on 23 and became less marked on 24</td>
</tr>
<tr>
<td>11.</td>
<td>Between 3.1 and 4.5 km a.s.l.</td>
<td>15</td>
<td>Coastal Karnataka &amp; adjoining Arabian Sea</td>
<td>Stationary</td>
<td><em>In situ</em></td>
<td>Became less marked on 16</td>
</tr>
</tbody>
</table>
## TABLE 2 (Contd.)

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.</td>
<td>Upto 3.1 km a.s.l.</td>
<td>17-20</td>
<td>Kerala and neighbourhood</td>
<td>East</td>
<td>East central and adjoining west central Arabian Sea</td>
<td>Moved away on 21</td>
</tr>
<tr>
<td>13.</td>
<td>At 1.5 km a.s.l.</td>
<td>18-20</td>
<td>East Bangladesh &amp; neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 21</td>
</tr>
<tr>
<td>14.</td>
<td>Do</td>
<td>18</td>
<td>South Coastal Andhra Pradesh and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 19</td>
</tr>
<tr>
<td>15.</td>
<td>At 0.9 km a.s.l.</td>
<td>19-20</td>
<td>Coastal Karnataka &amp; neighbourhood</td>
<td>South</td>
<td>North Kerala and adjoining Coastal Karnataka</td>
<td>Became less marked on 21</td>
</tr>
<tr>
<td>16.</td>
<td>At 5.8 km a.s.l.</td>
<td>21</td>
<td>East Rajasthan and neighbourhood</td>
<td>Stationary</td>
<td>Southwest Madhya Pradesh &amp; neighbourhood</td>
<td>Became less marked on 22</td>
</tr>
<tr>
<td>17.</td>
<td>At 0.9 km a.s.l.</td>
<td>21</td>
<td>Southwest Bay of Bengal off Sri Lanka Tamilnadu coasts to Lakshadweep</td>
<td>Do</td>
<td>In situ</td>
<td>Became less marked on 22</td>
</tr>
<tr>
<td>18.</td>
<td>At 1.5 km a.s.l.</td>
<td>21</td>
<td>From Lakshadweep-Maldives area</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 22</td>
</tr>
<tr>
<td>19.</td>
<td>Do</td>
<td>22-23</td>
<td>Southwest Rajasthan &amp; adjoining Pakistan</td>
<td>East</td>
<td>South Rajasthan &amp; neighbourhood</td>
<td>Became less marked on 24</td>
</tr>
<tr>
<td>20.</td>
<td>Do</td>
<td>23-27</td>
<td>Central Pakistan &amp; neighbourhood</td>
<td>Do</td>
<td>East Rajasthan &amp; neighbourhood</td>
<td>Became less marked on 28</td>
</tr>
<tr>
<td>21.</td>
<td>Upto 3.1 km a.s.l.</td>
<td>24-26</td>
<td>Gulf of Siam</td>
<td>West</td>
<td>South Andaman Sea &amp; neighbourhood</td>
<td>Became less marked on 27</td>
</tr>
<tr>
<td>22.</td>
<td>Upto 1.5 km a.s.l.</td>
<td>25</td>
<td>Gulf of Mannar &amp; neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 26</td>
</tr>
<tr>
<td>23.</td>
<td>Upto 4.5 km a.s.l.</td>
<td>25-27</td>
<td>Sub-Himalayan West Bengal &amp; Sikkim and neighbourhood</td>
<td>East</td>
<td>Bangladesh</td>
<td>Became less marked on 28</td>
</tr>
<tr>
<td>24.</td>
<td>Upto 2.1 km a.s.l.</td>
<td>25</td>
<td>South Assam &amp; neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 26</td>
</tr>
<tr>
<td>25.</td>
<td>Do</td>
<td>27-31</td>
<td>Southwest Bay of Bengal off Sri Lanka coast</td>
<td>North</td>
<td>Embedded in the trough of low from Southwest Bay of Bengal to West Central Bay of Bengal off south Andhra Pradesh</td>
<td>Became less marked on 31 November</td>
</tr>
<tr>
<td>26.</td>
<td>Upto 5.8 km a.s.l.</td>
<td>28-30</td>
<td>Central Bay of Bengal &amp; neighbourhood</td>
<td>Do</td>
<td>Westcentral and adjoining areas of northwest Bay of Bengal and north Andhra Pradesh and south Odisha coasts between 3.1 km &amp; 5.8 km above m.s.l. on 30</td>
<td>Lay embedded in the trough of low over southwest Bay of Bengal to North Bay of Bengal on 2 and became less marked on 31</td>
</tr>
<tr>
<td>27.</td>
<td>At 1.5 km a.s.l.</td>
<td>27-29</td>
<td>East Uttar Pradesh &amp; neighbourhood</td>
<td>South</td>
<td>North Chhattisgarh &amp; neighbourhood</td>
<td>Became less marked on 30</td>
</tr>
<tr>
<td>28.</td>
<td>Between 2.1 and 3.1 km a.s.l.</td>
<td>28</td>
<td>northern parts of West Bengal &amp; neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 29</td>
</tr>
</tbody>
</table>
### TABLE 2 (Cont.)

<p>| | | | | | | |</p>
<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>29.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>29</td>
<td>Maldives- Lakshadweep area</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 30</td>
</tr>
<tr>
<td>30.</td>
<td>Between 3.1 and 4.5 km a.s.l.</td>
<td>30-31</td>
<td>Eastcentral and adjoining areas of southeast Arabian Sea &amp; Karnataka</td>
<td>East</td>
<td>South Interior Karnataka &amp; neighbourhood</td>
<td>Became less marked on 1 November</td>
</tr>
</tbody>
</table>

## (E) Other troughs/Wind discontinuity

1. A trough at 1.5 kms a.s.l. ran from 1-4 | From Comorin area to north Kerala | Oscillatory | South Kerala and adjoining interior Tamil Nadu to north Konkan across Karnataka | Became less marked on 5 |

2. Upto 3.1 km a.s.l. | 12-14 | From the Deep Depression over Odisha to Kerala across Coastal Andhra Pradesh and Tamil Nadu | East | From Odisha to south Tamilnadu across Coastal Andhra Pradesh | Became less marked on 15 |

3. Do | 14 | From the Central Assam cyclonic circulation to north Bay across east Bangla Desh and Tripura | Do | From the East Assam cyclonic circulation to north Bay of Bengal | Became less marked on 15 |

4. At 5.8 kms a.s.l. | 20-21 | From South East Arabian Sea off Kerala coast to North Interior Karnataka | Oscillatory | From Maldives area to South Interior Karnataka at 5.8 kms a.s.l. | Became less marked on 22 |

5. Between 2.1 and 3.6 km a.s.l. | 20 | Along Long. 93° E to the north of Lat. 26° N | Stationary | In situ | Became less marked on 21 |

6. Upto 0.9 km a.s.l. | 23 | From South Interior Karnataka to north Madhya Maharashatra | Do | Do | Became less marked on 24 |

7. Upto 2.1 km a.s.l. | 23 | From Sikkim to Manipur | Do | Do | Became less marked on 24 |

8. At 0.9 km a.s.l. | 24 | From Telangana to southeast Vidarbha | Do | Do | Became less marked on 25 |

9. At 3.1 km a.s.l. | 24 | Long. 90° E to the north of 25° N at 3.1 kms a.m.s.l. on 24 | Do | Do | Became less marked on 25 |

10. At 0.9 km a.s.l. | 25 | From the cyclonic circulation over Gulf of Mannar & neighbourhood to south Madhya Maharashatra across interior Tamilnadu & Karnataka | Do | Do | Became less marked on 26 |

11. At 5.8 km a.s.l. | 26 | From Maldives area to Lakshadweep area | Do | Do | Moved away westward |

12. Upto 2.1 km a.s.l. | 27 | From circulation over southwest Bay of Bengal off Sri Lanka coast to eastcentral Bay of Bengal | Do | Do | Became less marked on 28 |
3.1.2. Commencement of northeast monsoon rains

With the establishment of the northeasterly winds in the lower tropospheric levels along the east coast, the northeast monsoon rains commenced over Tamil Nadu and Puducherry, Kerala, adjoining areas of Andhra Pradesh and Karnataka from 1st November, eleven days later than the normal date of 20th October. The simultaneous occurrence of the two VSCS delayed the setting in of easterlies and swept moisture away from the NEM region delaying the commencement of NEM.

3.1.3. Storms and Depressions

The formation of the two VSCS ‘Titli’ and ‘Luban’ on two sides of the Indian mainland in a ‘rarest of rare’ occurrence was the highlight of the month. The occurrence of such two VSCSs last occurred in November 1977, viz., (i) Bay of Bengal Super Cyclonic Storm (14-20 November, 1977), which crossed Andhra Pradesh coast near Chirala on 19th November and (ii) Bay of Bengal VSCS (9-23 November 1977), which crossed Tamil Nadu coast close to south of Nagapattinam on 12th November and then emerged into Arabian Sea, made a looping track, intensified into a SCS, weakened thereafter and crossed Karnataka coast to the north of Mangalore on 29th November as a depression. Prior to 1977 it was during 1971 that two SCS formed over Arabian Sea (27 October to 1 November) and Bay of Bengal (26-31 October). The Bay of Bengal cyclone made landfall close to Paradip in Odisha while the Arabian Sea system moved west and made landfall near Somalia.

Associated with the movement of the VSCS ‘Titli’ widespread rainfall recorded with heavy to very heavy rainfall at many places over coastal Odisha, Gangetic West Bengal and adjoining north Bay of Bengal upto Assam with extremely heavy falls at isolated places over coastal Odisha viz., G Udayagiri-35cms, Kantapada-32 cms, Raikia and Banki-28 cms each, Mohana-24 cms on 11th.

3.1.4. Other synoptic features and associated weather

Table 2 gives a summary of the synoptic features for the month of October 2018. The sub-divisional percentage departures of rainfall from normal and significant amounts of rainfall are given in Tables 1 and 5, respectively.

In the first fortnight precipitation caused by western disturbances was limited mostly to northern parts of the country especially Jammu & Kashmir and in the third week extending to Punjab and Himachal Pradesh.

In the month of October out of 36 meteorological subdivisions, 5 received normal rainfall, 7 deficient and 24 large deficient rainfall (Fig. 2). No subdivision recorded Excess or Large Excess rainfall. Out of the 5 normal subdivisions 4 were from Peninsula and one from Central India (Odisha), this is attributed mainly to the rainfall because of VSCS Titli.

3.1.5. Temperature

The maximum temperatures remained normal or above normal throughout except days when the temperatures dropped to appreciably below normal in some and markedly below normal in few subdivisions (Odisha, Bihar and Jharkhand) in correspondence with the landfall and movement of VSCS Titli. Over central India and Peninsula the day temperatures were markedly above normal or appreciably above normal on many days. Deficient rainfall (~56% of LPA) nearing large deficit during the month kept the maximum temperatures above normal in general.

The minimum temperatures in this month were normal or below normal over the country. Over most subdivisions from Northwest India, East and Northeast India the night temperatures were appreciably below normal on 5 to 8 days after 10th and over Jammu and Kashmir divisions they were appreciably below normal on most days.

No heat wave/cold wave condition occurred during the month. The month’s and the season’s highest maximum temperature was 42.2 °C recorded at Bhuj (Saurashtra & Kutch) on 6th and 7th October and the lowest minimum temperature of the month was 9.2 °C recorded at Mandla (East Madhya Pradesh) on 29th October, in the plains of the country.

3.1.6. Damages associated with Disastrous weather events

VSCS Titli was the most destructive cyclonic storm to strike Indian coast during 2018. As per situation report prepared by Odisha’s Special Relief Commissioner’s Office, VSCS Titli affected 16 out of the 30 districts in Odisha. More than 5.7 million people across 7,402 villages were affected, 18 people lost their lives. The State saw immense infrastructural damage, which highlights the long-term economic loss that accompanies natural disasters. The storm damaged more than 20,000 houses. It also destructed several bridges, culverts, embankments and roads in the State, around 0.75 million livestock died and crops on 0.58 million-acre land were destroyed. The fishing industry also lost 300 boats, 473 nets, 607 fish ponds, 69 fish seed farms and 14.66-hectare fish farms. Andhra Pradesh also faced considerable losses because of the cyclone, where 9 people died, while 1 was injured. The devastation was restricted to the two districts of Srikakulam and
## TABLE 3
Details of the weather systems during November 2018

<table>
<thead>
<tr>
<th>S. No.</th>
<th>System</th>
<th>Duration</th>
<th>Place of initial Location</th>
<th>Direction of movement</th>
<th>Place of final location</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
</tr>
<tr>
<td>(A)</td>
<td>Cyclonic storm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Severe Cyclonic storm ‘GAJA’</td>
<td>10-19</td>
<td>Southeast Bay of Bengal near Lat. 11.7° N/ Long. 92.5° E</td>
<td>West</td>
<td>Southeast Arabian Sea</td>
<td>It crossed Tamilnadu &amp; Puducherry coast between near Lat. 10.5° N and Long. 79.8° E on 16 November. Thereafter, it moved nearly westwards and weakened rapidly into an SCS. Details are given in the article on Storms &amp; Depressions over the north Indian Ocean-2018.</td>
</tr>
<tr>
<td>(B)</td>
<td>Well marked Low Pressure area/Low Pressure area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Well marked Low pressure area</td>
<td>5-7</td>
<td>Southwest Bay of Bengal off Sri Lanka and adjoining equatorial Indian Ocean</td>
<td>Northwest</td>
<td>Southwest Bay of Bengal and adjoining southeast Tamil Nadu and Comorin area</td>
<td>Became less marked in the morning of 8, however, the associated cyclonic circulation over the same region extended upto 3.1 kms above m.s.l. on 8-9, under the influence of the cyclonic circulation over Comorin area and adjoining Sri Lanka and equatorial Indian Ocean, a low pressure area formed over the Comorin area and neighbourhood on 9 evening. It lay as a trough of low at mean sea level from Maldives Comorin area to Lakshadweep area with an embedded cyclonic circulation extending upto 1.5 kms above m.s.l. on 10 became less marked on 11. However, the cyclonic circulation extending upto 1.5 kms above m.s.l. over Lakshadweep area lay over southeast Arabian Sea &amp; adjoining Lakshadweep area on 11, became less marked on 12</td>
</tr>
<tr>
<td>(C)</td>
<td>Western disturbances /eastward moving systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Upper air cyclonic circulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Between 3.6 and 4.5 km a.s.l.</td>
<td>8-9</td>
<td>Between 3.6 and 4.5 kms above m.s.l. over north Pakistan and neighbourhood</td>
<td>East</td>
<td>Northern parts of Jammu &amp; Kashmir and neighbourhood</td>
<td>Moved away East north eastwards</td>
</tr>
<tr>
<td>2.</td>
<td>At 3.1 km a.s.l.</td>
<td>10-14</td>
<td>Northeast Afghanistan &amp; neighbourhood</td>
<td>Do</td>
<td>Jammu &amp; Kashmir and neighbourhood</td>
<td>Became less marked on 15</td>
</tr>
<tr>
<td>3.</td>
<td>Do</td>
<td>17-20</td>
<td>North Pakistan and neighbourhood</td>
<td>East northeast</td>
<td>Jammu &amp; Kashmir</td>
<td>Moved away north eastwards</td>
</tr>
<tr>
<td>4.</td>
<td>Do</td>
<td>23-26</td>
<td>Northeast Afghanistan and neighbourhood</td>
<td>Do</td>
<td>Jammu Kashmir and neighbourhood</td>
<td>Moved away East north eastwards</td>
</tr>
<tr>
<td>(ii)</td>
<td>Trough in westerlies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>At 3.1 km a.s.l.</td>
<td>20-21</td>
<td>Along Long. 67° E to the north of 33° N</td>
<td>East-northeast</td>
<td>Along Long. 75.0° E to the north of Lat. 32.0° N</td>
<td>Moved away east northeastwards</td>
</tr>
<tr>
<td>2.</td>
<td>At 5.8 km a.s.l.</td>
<td>21-22</td>
<td>Long. 55° E to the north of 26° N</td>
<td>Do</td>
<td>Roughly along Long. 75° E</td>
<td>Moved away east northeastwards</td>
</tr>
<tr>
<td>3.</td>
<td>Do</td>
<td>26-28</td>
<td>Along Long. 52° E to the north of Lat. 25° N (axis at 5.8 kms a.s.l.)</td>
<td>Do</td>
<td>Northeast Afghanistan and neighbourhood</td>
<td>It lay as a cyclonic circulation extending upto 3.1 kms above m.s.l. over northeast Afghanistan and neighbourhood with the trough aloft. Moved away east northeastwards</td>
</tr>
</tbody>
</table>
TABLE 3 (Contd.)

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>(iii) As an Induced cyclonic circulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>2-4</td>
<td>Punjab &amp; neighbourhood</td>
<td>East</td>
<td>Haryana &amp; adjoining West Uttar Pradesh</td>
<td>Became less marked on 5. *The WD system is shown in the Table of October [C(i)8]</td>
</tr>
<tr>
<td>2.</td>
<td>Do</td>
<td>13-15</td>
<td>West Rajasthan and neighbourhood</td>
<td>Northeast</td>
<td>Haryana and neighbourhood</td>
<td>Became less marked on 16</td>
</tr>
<tr>
<td>3.</td>
<td>Do</td>
<td>22</td>
<td>West Rajasthan and neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 23</td>
</tr>
<tr>
<td>4.</td>
<td>At 1.5 km a.s.l.</td>
<td>27</td>
<td>Central Pakistan &amp; neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 28</td>
</tr>
</tbody>
</table>

(D) Other upper air cyclonic circulations

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</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Between 3.1 and 4.5 km a.s.l.</td>
<td>1-2</td>
<td>Southeast Arabian Sea &amp; adjoining Coastal Karnataka</td>
<td>North</td>
<td>Eastcentral Arabian Sea and adjoining southeast Arabian Sea &amp; Coastal Karnataka</td>
<td>Became less marked on 3</td>
</tr>
<tr>
<td>2.</td>
<td>Between 1.5 &amp; 2.1 km a.s.l.</td>
<td>1-4</td>
<td>South Tamilnadu &amp; neighbourhood</td>
<td>West</td>
<td>Maldives &amp; adjoining Lakshadweep area</td>
<td>Became less marked on 5</td>
</tr>
<tr>
<td>3.</td>
<td>At 0.9 km a.s.l.</td>
<td>4</td>
<td>Southeast Rajasthan &amp; neighbourhood at 0.9 km</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 5</td>
</tr>
<tr>
<td>4.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>4-8</td>
<td>East Assam &amp; neighbourhood</td>
<td>South</td>
<td>South Assam &amp; neighbourhood</td>
<td>A trough lay aloft roughly along Long. 93° E to the north of Lat. 24° N at 2.1 km above m.s.l. it became less marked on 5. The cyclonic circulation became less marked on 9</td>
</tr>
<tr>
<td>5.</td>
<td>Upto 1.5 km a.s.l.</td>
<td>5-7</td>
<td>North Madhya Maharashtra &amp; neighbourhood</td>
<td>East</td>
<td>South Chhattisgarh &amp; neighbourhood</td>
<td>Became less marked on 8</td>
</tr>
<tr>
<td>6.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>6</td>
<td>North interior Karnataka &amp; adjoining Telangana</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 7</td>
</tr>
<tr>
<td>7.</td>
<td>At 5.8 km a.s.l.</td>
<td>6</td>
<td>Eastcentral Arabian Sea and adjoining Coastal Karnataka</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 7</td>
</tr>
<tr>
<td>8.</td>
<td>Between 3.1 &amp; 4.5 km a.s.l.</td>
<td>8-13</td>
<td>West Assam and neighbourhood</td>
<td>West</td>
<td>Northeast Bangla Desh and neighbourhood</td>
<td>Became less marked on 14</td>
</tr>
<tr>
<td>9.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>9</td>
<td>Lakshadweep and neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 10</td>
</tr>
<tr>
<td>10.</td>
<td>At 0.9 km a.s.l.</td>
<td>13</td>
<td>South interior Karnataka and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 14</td>
</tr>
<tr>
<td>11.</td>
<td>At 3.1 km a.s.l.</td>
<td>14</td>
<td>North Kerala coast and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 15</td>
</tr>
<tr>
<td>12.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>16</td>
<td>Assam &amp; neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 17</td>
</tr>
<tr>
<td>13.</td>
<td>Do</td>
<td>18-19</td>
<td>North Bangladesh and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 20</td>
</tr>
<tr>
<td>14.</td>
<td>At 0.9 km a.s.l.</td>
<td>19-20</td>
<td>Southwest Rajasthan and neighbourhood</td>
<td>Northeast</td>
<td>East Rajasthan and neighbourhood</td>
<td>Became less marked on 21</td>
</tr>
</tbody>
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TABLE 3 (Contd.)

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<th>(1)</th>
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</thead>
<tbody>
<tr>
<td>15.</td>
<td>At 1.5 km a.s.l.</td>
<td>20</td>
<td>Sub-Himalayan West Bengal &amp; neighbourhood</td>
<td>Stationary</td>
<td><em>In situ</em></td>
<td>Became less marked on 21</td>
</tr>
<tr>
<td>16.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>20-25</td>
<td>Gulf of Siam and neighbourhood</td>
<td>Southwest</td>
<td>Equatorial Indian Ocean and adjoining Sumatra</td>
<td>Became less marked on 26</td>
</tr>
<tr>
<td>17.</td>
<td>Upto 5.8 km a.s.l.</td>
<td>26-29</td>
<td>Gulf of Siam and neighbourhood</td>
<td>Do</td>
<td>Equatorial Indian Ocean and adjoining Sumatra</td>
<td>Became less marked on 30</td>
</tr>
<tr>
<td>18.</td>
<td>At 1.5 km a.s.l.</td>
<td>28-30</td>
<td>Maldives-Comorin areas</td>
<td>West</td>
<td>Equatorial Indian Ocean and adjoining southeast Arabian Sea</td>
<td>Became less marked on 1 December</td>
</tr>
<tr>
<td>19.</td>
<td>Between 1.5 &amp; 3.6 km a.s.l.</td>
<td>29-30</td>
<td>East central Arabian Sea off south Maharashtra - Goa coasts</td>
<td>East</td>
<td>Konkan and adjoining Madhya Maharashtra</td>
<td>Became less marked on 1 December</td>
</tr>
<tr>
<td>20.</td>
<td>Between 3.1 &amp; 3.6 km a.s.l.</td>
<td>30 Nov-2 Dec</td>
<td>West central Bay of Bengal off Andhra Pradesh coast</td>
<td>Southwest</td>
<td>South coastal Andhra Pradesh and adjoining west central Bay of Bengal</td>
<td>Became less marked on 3 December</td>
</tr>
</tbody>
</table>

(E) Trough in easterlies

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
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<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>At 0.9 km a.s.l.</td>
<td>19-21</td>
<td>From North interior Karnataka to Vidarbha across Marathwada</td>
<td>Oscillatory</td>
<td>From eastcentral Arabian Sea off south Maharashtra coast to north Madhya Maharashtra</td>
<td>Became less marked on 22</td>
</tr>
<tr>
<td>2.</td>
<td>At 5.8 km a.s.l.</td>
<td>23-24</td>
<td>From Comorin area to interior Tamil Nadu</td>
<td>West</td>
<td>From southeast Arabian Sea off Lakshadweep area to north interior Karnataka across coastal Karnataka</td>
<td>Became less marked on 25</td>
</tr>
<tr>
<td>3.</td>
<td>At mean sea level</td>
<td>30 Nov-8 Dec</td>
<td>Equatorial Indian Ocean and adjoining south Andaman Sea</td>
<td>Do</td>
<td>Maldives Lakshadweep area</td>
<td>Became less marked on 9 December</td>
</tr>
</tbody>
</table>

(F) Other troughs / Wind discontinuity

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>2</td>
<td>Along Long. 90° E to the north of Lat. 22° N</td>
<td>Stationary</td>
<td><em>In situ</em></td>
<td>Became less marked on 3</td>
</tr>
<tr>
<td>2.</td>
<td>Do</td>
<td>6-7</td>
<td>From East Bihar to Gangetic West Bengal</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 8</td>
</tr>
<tr>
<td>3.</td>
<td>Between 1.5 and 2.1 km a.s.l.</td>
<td>17</td>
<td>Roughly along Long. 88° E to the north of Lat. 26° N</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 18</td>
</tr>
<tr>
<td>4.</td>
<td>At 1.5 km a.s.l.</td>
<td>18</td>
<td>Roughly from north Bihar to south Assam across northern parts of West Bengal and Bangladesh</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 19</td>
</tr>
</tbody>
</table>
Vizianagaram in the State. The total affected population was almost 12.5 lakh spread across 872 villages and 40,000 houses worth more than Rs. 400 crore were destroyed by the cyclone. The loss due to crop damages is pegged at a massive Rs. 800 crore. The horticultural sector also incurred significant losses of Rs. 1,000 crore due to the cyclone. Cashew and coconut plantations, which were considered long-term sources of livelihood for the farmers, had been severely damaged in Srikakulam district (Cashew trees in 44,500 acres and coconut trees in 34,600 acres).

3.2. November

3.2.1. Storms and Depressions

Very Severe Cyclonic Storm (VSCS) Gaja, which formed in this month was the first ever looping track cyclone over the Bay of Bengal after 1996. The system had one of the longest track length equal to 3418 km and life period (D to D) of the system was 219 hours (9 days and 3 hours) against long period average (LPA) (1990-2013) of 98 hours for SCS category over Bay of Bengal during post monsoon season. Under the influence of the system, rainfall occurred at most places with heavy falls at a few places and very heavy falls at isolated places over Tamil Nadu, moderate rainfall over Kerala, south coastal Andhra Pradesh, Rayalaseema and south interior Karnataka on 16th and 17th.

3.2.2. Weather and associated synoptic features

A summary of the synoptic systems for the month of November 2018 is given in Table 3. The sub-division wise percentage departure of rainfall from normal and the significant amounts of rainfall during the month are given in Tables 1 and 5 respectively.

The systems in the westerlies gave rain/snow in the northern subdivisions of Northwest Region viz., Jammu and Kashmir, Uttarakhand and Himachal Pradesh which received nearly double the precipitation of normal for the month. Out of the six remaining subdivisions five were large deficient and one deficient (Punjab).

In the second fortnight, the landfall of cyclonic storm, ‘Gaja’, its westward movement over the peninsula and various troughs and cyclonic circulations resulted in precipitation in many subdivisions of South India resulting in the North East monsoon being active for a few days over the southern parts of the peninsula and vigorous on 16th in Tamil Nadu and Puducherry. There was some activity due to the western disturbances and their induced systems enhancing precipitation in North India upto the third week of this month, while the weather remained totally dry in the last week except for some subdivisions of south peninsula particularly in Rayalaseema, Tamil Nadu and Kerala.

3.2.3. Temperature

Cold day and cold wave conditions were not observed in this month.

The minimum temperatures over most subdivisions were normal or below normal in the month except first week when they were above normal or appreciably above normal on a few days. The night temperatures over Central India and Peninsular India remained above normal or appreciably above normal for few days in the

<table>
<thead>
<tr>
<th>(1)</th>
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<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Between 2.1 and 3.6 km a.s.l.</td>
<td>20</td>
<td>Along Long. 93° E to the north of Lat. 25° N</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 21</td>
<td></td>
</tr>
<tr>
<td>6. Between 1.5 and 3.1 kms above m.s.l.</td>
<td>22</td>
<td>From the cyclonic circulation over interior Tamilnadu &amp; neighbourhood to Maldives area across interior Tamilnadu and Kerala</td>
<td>North South</td>
<td>Long. 90.0° E to north of Lat. 25.0° N</td>
<td>Became less marked on 23</td>
<td></td>
</tr>
<tr>
<td>7. At mean sea level</td>
<td>29-30</td>
<td>From equatorial Indian Ocean &amp; adjoining southwest Bay of Bengal off south Sri - Lanka coast ran from Comorin area to southwest Bay of Bengal off south Tamil Nadu coast on 29</td>
<td>East</td>
<td>Equatorial Indian Ocean and adjoining southeast Arabian Sea</td>
<td>Became less marked on 1 December</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 4
Details of the weather systems during December 2018

<table>
<thead>
<tr>
<th>S. No.</th>
<th>System</th>
<th>Duration</th>
<th>Place of initial Location</th>
<th>Direction of movement</th>
<th>Place of final location</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td><strong>Severe Cyclonic Storm</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Severe Cyclonic Storm, “PHETHAI”</strong></td>
<td>13-17</td>
<td>Southwest Bay of Bengal</td>
<td>North north westwards</td>
<td>Northwest Bay of</td>
<td>Low pressure area over northwest Bay of Bengal and adjoining coastal Odisha, associated cyclonic circulation extended upto 1.5 kms above m.s.l. over northwest Bay of Bengal and adjoining coastal areas of west Bengal and north Odisha on 18 evening and became less marked on 19. Details are given in the article on Storms &amp; Depressions over the north Indian Ocean-2018</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bengal &amp; adjoining coastal Odisha</td>
<td></td>
</tr>
<tr>
<td>(B)</td>
<td><strong>Western disturbances/Eastward moving systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td><strong>Upper air cyclonic circulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Initially it lay as a trough along Long. 62° E to the north of Lat. 32° N on 6 and 7. A trough aloft with its axis at 5.8 kms above m.s.l. ran roughly along Long. 66° E to the north of Lat. 28° N from 10th and became less marked on 15. The cycir became less marked on 13</td>
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</tr>
<tr>
<td></td>
<td>Initially it lay as a trough in mid and upper tropospheric westerlies with its axis at 3.1 kms above m.s.l. and ran roughly along Long. 54° E to the north of Lat. 34° N on 22. The cycir lay with a trough aloft running roughly along Long. 62° E to the north of Lat. 28° N at 5.8 kms above m.s.l. on 23. Moved away east northeastwards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Initially WD as a trough in mid and upper tropospheric westerlies with its axis at 3.1 kms above m.s.l. and ran roughly along Long. 60° E to the north of Lat. 32° N on 25. Cycir became less marked on 27. However, WD as a trough moved away east-northeastwards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td><strong>As a trough/ Trough in westerlies</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Initially WD as a trough in mid and upper tropospheric westerlies with its axis at 3.1 kms above m.s.l. and ran roughly along Long. 60° E to the north of Lat. 32° N on 25. Cycir became less marked on 27. However, WD as a trough moved away east-northeastwards</td>
<td></td>
<td></td>
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</table>
### TABLE 4 (Contd.)

<table>
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<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Mid tropospheric levels</td>
<td>3-7</td>
<td>Along Long. 55° E to the north of Lat. 34° N (axis at 5.8 kms a.s.l.)</td>
<td>East</td>
<td>Along Long. 82° E to the north of Lat. 34° N</td>
<td>The WD moved away north eastwards</td>
</tr>
<tr>
<td>3.</td>
<td>At 3.1 km a.s.l.</td>
<td>17-19</td>
<td>Roughly along Long. 65° E to north of Lat. 30° N</td>
<td>East north eastwards</td>
<td>Jammu &amp; Kashmir and neighbourhood</td>
<td>The Feeble WD moved away east north eastwards</td>
</tr>
<tr>
<td>4.</td>
<td>Mid &amp; lower tropospheric levels with its axis at 3.1 kms above m.s.l.</td>
<td>18</td>
<td>Roughly along Long. 90° E to the north of Lat. 25° N</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 19</td>
</tr>
<tr>
<td>5.</td>
<td>Between 3.1 &amp; 3.6 kms above m.s.l.</td>
<td>19-20</td>
<td>Roughly along Long. 62° E to the north of Lat. 32° N</td>
<td>East north eastwards</td>
<td>Roughly along Long. 70° E to the north of Lat. 34° N on 20</td>
<td>The Feeble WD moved away east north eastwards</td>
</tr>
<tr>
<td>6.</td>
<td>At 3.1 kms above m.s.l.</td>
<td>26-27</td>
<td>Roughly along Long. 93° E to the north of Lat. 25° N</td>
<td>Stationary</td>
<td>In situ</td>
<td>Moved away eastwards</td>
</tr>
</tbody>
</table>

(iii) **As an induced cyclonic circulation**

<table>
<thead>
<tr>
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<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Upto 1.5 km a.s.l.</td>
<td>10-12</td>
<td>Central Pakistan &amp; adjoining west Rajasthan</td>
<td>East</td>
<td>East Rajasthan</td>
<td>Became less marked on 13</td>
</tr>
<tr>
<td>2.</td>
<td>Do</td>
<td>23</td>
<td>Central Pakistan &amp; adjoining Punjab and west Rajasthan</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 24</td>
</tr>
</tbody>
</table>

(C) **Other upper air cyclonic circulations**

<table>
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<tr>
<th>(1)</th>
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<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>At 3.1 kms above m.s.l.</td>
<td>1-3</td>
<td>Coastal Karnataka and neighbourhood</td>
<td>East</td>
<td>South interior Karnataka and neighbourhood</td>
<td>Became less marked on 4</td>
</tr>
<tr>
<td>2.</td>
<td>Between 3.1 and 3.6 km a.s.l.</td>
<td>3</td>
<td>Lakshadweep area and adjoining southeast Arabian Sea</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 4</td>
</tr>
<tr>
<td>3.</td>
<td>At 3.1 kms above m.s.l.</td>
<td>4</td>
<td>Eastcentral Arabian Sea and adjoining coastal Karnataka</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 5</td>
</tr>
<tr>
<td>4.</td>
<td>Between 3.1 and 3.6 km a.s.l.</td>
<td>4</td>
<td>East Assam and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 6</td>
</tr>
<tr>
<td>5.</td>
<td>Upto 3.1 km a.s.l.</td>
<td>5-8</td>
<td>Equatorial Indian Ocean and adjoining southwest Bay of Bengal</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 9</td>
</tr>
<tr>
<td>6.</td>
<td>At 3.1 kms a.s.l.</td>
<td>5</td>
<td>Konkan and adjoining Madhya Maharashtra</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 6</td>
</tr>
<tr>
<td>7.</td>
<td>Upto 0.9 kms a.s.l.</td>
<td>6</td>
<td>North Konkan and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 7</td>
</tr>
<tr>
<td>8.</td>
<td>At 3.1 km a.s.l.</td>
<td>7-8</td>
<td>Sub-Himalayan West Bengal &amp; adjoining west Assam</td>
<td>West</td>
<td>Sub Himalayan West Bengal and neighbourhood</td>
<td>Became less marked on 9</td>
</tr>
<tr>
<td>9.</td>
<td>Upto 1.5 km a.s.l.</td>
<td>8</td>
<td>Mizoram &amp; neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 9</td>
</tr>
<tr>
<td>10.</td>
<td>At 1.5 km a.s.l.</td>
<td>8</td>
<td>West Uttar Pradesh and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 9</td>
</tr>
<tr>
<td>11.</td>
<td>At 3.1 kms a.s.l.</td>
<td>9-17</td>
<td>East Bangladesh and neighbourhood</td>
<td>Oscillatory</td>
<td>Bangladesh and neighbourhood</td>
<td>Became less marked on 18</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>12.</td>
<td>Upto 0.9 kms a.s.l.</td>
<td>10</td>
<td>North Madhya Maharashtra and neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 11</td>
</tr>
<tr>
<td>13.</td>
<td>Do</td>
<td>11-12</td>
<td>North Chhattisgarh &amp; neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 13</td>
</tr>
<tr>
<td>14.</td>
<td>At 0.9 km a.s.l.</td>
<td>12-13</td>
<td>North interior Karnataka and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 14</td>
</tr>
<tr>
<td>15.</td>
<td>At 3.1 km a.s.l.</td>
<td>14</td>
<td>South Madhya Maharashtra and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 15</td>
</tr>
<tr>
<td>16.</td>
<td>Do</td>
<td>15-16</td>
<td>East central Arabian Sea off South Maharashtra and North Karnataka coast</td>
<td>North</td>
<td>East central Arabian Sea off north Maharashtra</td>
<td>Became less marked on 17</td>
</tr>
<tr>
<td>17.</td>
<td>At 1.5 km a.s.l.</td>
<td>16-17</td>
<td>Central parts of Uttar Pradesh and neighbourhood</td>
<td>West</td>
<td>East Uttar Pradesh and neighbourhood</td>
<td>Became less marked on 18</td>
</tr>
<tr>
<td>18.</td>
<td>Between 3.1 and 3.6 kms a.s.l.</td>
<td>18</td>
<td>Jammu &amp; Kashmir and neighbourhood</td>
<td>East</td>
<td>Eastern parts of Jammu &amp; Kashmir and neighbourhood</td>
<td>Initially it lay WD as a trough Roughly along Long. 65° E to north of Lat. 30° N on 17. Became less marked on 20</td>
</tr>
<tr>
<td>19.</td>
<td>Do</td>
<td>18</td>
<td>South Chhattisgarh &amp; neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 19</td>
</tr>
<tr>
<td>20.</td>
<td>Upto 1.5 km a.s.l.</td>
<td>19-22</td>
<td>Southeast Arabian Sea and adjoining Comorin area</td>
<td>Northeast</td>
<td>Eastcentral Arabian Sea and north coastal Maharashtra</td>
<td>Became less marked on 23</td>
</tr>
<tr>
<td>21.</td>
<td>At 1.5 km a.s.l.</td>
<td>20-21</td>
<td>East Bangladesh</td>
<td>North</td>
<td>South Assam and neighbourhood</td>
<td>Became less marked on 22</td>
</tr>
<tr>
<td>22.</td>
<td>At 4.5 km a.s.l.</td>
<td>20</td>
<td>East Arabian Sea &amp; adjoining coastal Karnataka</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 21</td>
</tr>
<tr>
<td>23.</td>
<td>At 1.5 km a.s.l.</td>
<td>22</td>
<td>East Uttar Pradesh and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 23</td>
</tr>
<tr>
<td>24.</td>
<td>At 3.1 km a.s.l.</td>
<td>22-24</td>
<td>Central Assam and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 25</td>
</tr>
<tr>
<td>25.</td>
<td>At 0.9 km a.s.l.</td>
<td>25</td>
<td>South interior Karnataka to south Madhya Maharashtra across north interior Karnataka</td>
<td>Do</td>
<td>Do</td>
<td>Merged with the trough in easterlies from Maldives area to Madhya Maharashtra</td>
</tr>
<tr>
<td>26.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>27-28</td>
<td>Comorin area &amp; neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 29</td>
</tr>
<tr>
<td>27.</td>
<td>Between 1.5 &amp; 2.1 kms above m.s.l.</td>
<td>28-29</td>
<td>Eastcentral Arabian Sea off Maharashtra coast</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 30</td>
</tr>
<tr>
<td>28.</td>
<td>Extending upto 0.9 km above m.s.l.</td>
<td>28</td>
<td>South coastal Odisha and adjoining north coastal Andhra Pradesh</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 29</td>
</tr>
<tr>
<td>29.</td>
<td>Upto 3.6 kms above m.s.l.</td>
<td>29</td>
<td>Coastal Karnataka and neighbourhood</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 30</td>
</tr>
<tr>
<td>30.</td>
<td>Upto 0.9 km above m.s.l.</td>
<td>30</td>
<td>Central Pakistan and adjoining northwest Rajasthan &amp; Punjab</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 31</td>
</tr>
</tbody>
</table>
### TABLE 4 (Contd.)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(D) Trough in easterlies</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>1.</td>
<td>At 0.9 km a.s.l.</td>
<td>7-9</td>
<td>South interior Karnataka to Madhya Pradesh across North Interior Karnataka</td>
<td>-</td>
<td>North interior Karnataka to north Madhya Pradesh</td>
<td>Became less marked on 10</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>13</td>
<td>North interior Karnataka to south Chhattisgarh across Telangana and Vidarbha</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 14</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>At 0.9 km a.s.l.</td>
<td>25</td>
<td>South interior Karnataka to Madhya Pradesh across North Interior Karnataka</td>
<td>Do</td>
<td>Do</td>
<td>Merged with the trough in easterlies from Maldives area to Madhya Pradesh on 26</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Do</td>
<td>26</td>
<td>From Maldives area to Madhya Pradesh across north Kerala and Interior Karnataka</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 27</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>30</td>
<td>Southeast Arabian Sea to eastcentral Arabian Sea off west coast</td>
<td>West</td>
<td>Southeast Arabian Sea off Kerala - Karnataka</td>
<td>Became less marked on 1 January, 2019</td>
<td></td>
</tr>
<tr>
<td><strong>(E) Other trough</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.</td>
<td>At mean sea level</td>
<td>1</td>
<td>Maldives area and neighbourhood</td>
<td>Stationary</td>
<td>In situ</td>
<td>Became less marked on 2</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Do</td>
<td>4</td>
<td>Southeast Arabian Sea and adjoining equatorial Indian</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 5</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>At 3.1 km a.s.l.</td>
<td>4</td>
<td>From cyclonic circulation over eastcentral Arabian Sea to Marathwada across north interior Karnataka</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 5</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Do</td>
<td>5</td>
<td>From east Bihar to northern parts of Gangetic West Bengal</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 7</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Upto 0.9 km a.s.l.</td>
<td>11</td>
<td>From cyclonic circulation over north Chhattisgarh &amp; neighbourhood to south Interior Karnataka across Vidarbha, Marathwada and north Interior Karnataka</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 12</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>At 3.1 km a.s.l.</td>
<td>15</td>
<td>From west Arunachal Pradesh to North Bangladesh</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 16</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>At 0.9 km a.s.l.</td>
<td>18</td>
<td>From cyclonic circulation over northwest Bay of Bengal and adjoining coastal Odisha to Rayalaseema</td>
<td>Do</td>
<td>Do</td>
<td>Became less marked on 19</td>
<td></td>
</tr>
</tbody>
</table>
third week, while over Northwest India the temperatures saw a rise in the last week of the month.

3.2.4. Damages associated with Disastrous weather events

Severe Cyclonic storm 'Gaja' which crossed the coast between Nagapattinam and nearby Vedaranyam claimed 46 lives. As per media reports, Tamil Nadu suffered crop loss of around 88,102 hectares of agriculture lands, 86702 electric poles, 841 transformers, 201 electricity substations and 4844 fishing boats. There was extensive damage to coconut and banana plantations, rice and other standing crops. More than 80 per cent of the palms in the region were uprooted, affecting the livelihood of the small and marginal farmers. Nagapattinam, Thanjavur, Tiruvarur, Pudukottai were the worst affected places in Tamil Nadu. Carcasses of a large number of animals and birds, suspected to be from Kodyakarai Wildlife Sanctuary, washed ashore. The storm also caused heavy damage to the 16th century shrine Basilica at Velankanni in Nagapattinam district.

Heavy rains and related incidents killed 4 people in Tamil Nadu in the second phase of the month in relation to the active monsoon conditions.

3.3. December

3.3.1. Storms and Depressions

The SCS “Phethai”, seventh cyclone over north Indian Ocean formed during 2018. Earlier such occurrence of 7 cyclones in a year was witnessed in 1985. It formed as a Low Pressure area over Equatorial Indian Ocean and adjoining central parts of south Bay of Bengal on 9th December. Gradually it intensified into CS “Phethai” in the evening of 15th and concentrated into a Severe Cyclonic Storm (SCS) in the afternoon of 16th. It weakened into CS before landfall over Andhra Pradesh Coast near 16.55°N and 82.25°E on 17th.

Under the influence of this system vigorous monsoon conditions were observed over Coastal Andhra Pradesh on 17th and 18th.

3.3.2. Weather and associated synoptic features

Table 4 gives a summary of the synoptic systems during the month of December 2018. The sub-division wise percentage departure of rainfall from normal and the significant amounts of rainfall during the month are given in Tables 1 and 5, respectively.

The major rain contributing system this month was the SCS “Phethai”. The sub-divisions influenced by this system recorded large excess rainfall, many times that of LPA.

The cyclonic circulation over Bangladesh and neighborhood from 13-18 enhanced rainfall activity in the East and Northeast India and was further aided by passage of western disturbances. The rainfall activity remained subdued in Northwest India as the western disturbances were short-lived/feeble and had more northerly tracks. Out

<table>
<thead>
<tr>
<th>TABLE 4 (Contd.)</th>
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<tbody>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>8. At 5.8 km a.s.l.</td>
</tr>
<tr>
<td>9. At mean sea level</td>
</tr>
<tr>
<td>10. Do</td>
</tr>
<tr>
<td>11. At 0.9 km a.s.l.</td>
</tr>
</tbody>
</table>
### TABLE 5

Some representative amounts of rainfall in cm for October, November and December 2018 (5 cm and above)

<table>
<thead>
<tr>
<th>Date</th>
<th>Some representative amounts of rainfall in cm for October, November and December 2018 (5 cm and above)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Oct</td>
<td>Neora 18, Murti 16, Nagarkata 14, Myladumparaa 9, Buxaduar 8, Periyakulam, Chintalapudi and Sankalan 7 each, Singla Bazar, Thodupuzha and Subramanya 6 each, Bagarakote, Chengmari / Diana, Mangan, CIAL Kochi, Hasimara, Santhamangulur and Garubathan 5 each</td>
</tr>
<tr>
<td>2 Oct</td>
<td>Kannur 12, Mangan and Alipurdur CWC 8 each, Coonoor 7, Paramakudy, Beki Mathungari, Krishnarajpet, N. Lakhimpur, Bhaluppong, Valpoi, Tadod, Eranool, Gangtok and Vilathikulam 6 each, Sattur, Surangudi, Aswapuram, Thalasserry, Tirumangalam, Watrap and Lanja 5 each</td>
</tr>
<tr>
<td>3 Oct</td>
<td>Tuljapur 9, Manamalikudi, Chalakudi and Thucklay 7 each, Nilanga 6, Ausa, Kodavasal, Tiruvurar, Panbari, Kuzhitthurai, Thodupuzha and Osmanabad 5 each</td>
</tr>
<tr>
<td>4 Oct</td>
<td>Alappuzha and Chalakudi 12 each, K.M. Koil and Pullambadi 11 each, Tiruchendur 10, Angadipuram, Vedaranimiyam, Sirkali, Mavelikara and Parambilukulam 9 each, Rameswaram, Umarga and Perinthalmanna 8 each, Pamban, Kumarakom, Cuddalore, Thrithala, Tirukuttapalli, Jayamkondam, Chittur, Sethiahope, Puducherry, Karkala, Thirumanur, Mani, Kayamkulam, Mayiladuthurai and Kodungallur 7 each, Madukkur, JavaliMedha, Mannargudi, Cheyur, Alathur, Piravam, Nannilam, Kanakial and Palakkkad 6 each, Mannaga, Anaikaranchatram (Kollidi), Sholavandan, Tiruppur, Adirampattinam, Poladpur, Parangipettai, Grand Anicut, Pandavayir Head, Shriwardhan, Tiruchengode, Thuvakudilinti, Purtti HMS, Needamangalam, Chidambaram, Pulnur, Thiruvidaimarudhur, Nagapattinam, Ottapalam and Mylamb WS 5 each</td>
</tr>
<tr>
<td>5 Oct</td>
<td>Ennore AWS 13, Chengalpattu 12, Kurudamannahil 11, Cholavaram 9, Kozha, Bantwal, Konni, Tailiparamba, Marakkanam, Vanur and Ponneri 8 each, Mudubidre, Palani, Pulnur, Tindivanam, Palayamkottai, Nagarcoil, Kozhikode, Madavaram AWS and Anaikaranchatram (Kollidi) 7 each, Chengam, Radhapuram, Kelambakkam, Maduranthagam, Ginge, Jayamkondam, Sathanur Dam, Mani, Tada, Red Hills, Puzhal ARG, Chennai AP, Poonamalle ARG and Uthangarai 6 each, AluvaPvd, Pechiparai, Uthiramnerur, Piravam, Chennai city, Tiruvannamalai, Munnar KSEB, Thiruthuraiponni, Kancheepuram, Sieperumbudur, Sullurpetta, Arani, Mahabalipuram, Kodavasal, Karkala, Purandar Vasvd, Shencottah, Tiruvurar, Dgp Office, Chembarakkam and Karikal 5 each</td>
</tr>
<tr>
<td>6 Oct</td>
<td>Karaikal 12, Vilupuram 9, Coonoor and Kollur 8 each, Neyveli AWS, Mylamb WS and Mayiladuthurai 7 each, Gersoppa, Mettupalayam, Lenganamakki HMS, Panutri, Needamangalam, Kancheepuram and Vanur 6 each, Cuddalore, Nagapattinam, Vedaranimiyam, Vellankkara, Thiruthuraiponni, Kothagiri, Ketti, Bantwal, Penucondapuram and Honavar 5 each</td>
</tr>
<tr>
<td>7 Oct</td>
<td>Sankaranercoil and Ambasamudram 8 each, Tiruppur, Thenkasi and Yagati 7 each, Kothagiri, Shencottah, AminiDivi, Pudukottai, Sathyamangalam, Tirupuvanam and Rameswaram 6 each, Panchananallil, R.S.Mangalam, Ramanathapuram, Coonoor, Agathi, Pattukottai, Long Islands, Maya Bandar, Jayamkondam, Hut Bay, Ayikudi, Bhavaniagrar, Maniyachi, Kanyakumari and Hosadurga 5 each</td>
</tr>
<tr>
<td>8 Oct</td>
<td>Tirupuvanam 15, Manamadurai and Port Blair 13 each, Long Islands and Chittampatti 12 each, Kodungallur, Lungei and Rameswaram 9 each, Paramakudi 8, Watrap and Tiruppur 7 each, Mettupatti, Peermao To, Periyakulam and Emanakulam 6 each, Thiruvananthapuram, Illayangudi, Vadipatty and R.S. Mangalam 5 each</td>
</tr>
<tr>
<td>9 Oct</td>
<td>Subramanya 16, Mahat 15, Tirupur and Mangaluru 11 each, Vadipatti, Panambur and Thallasserry 9 each, AluvaPvd and Ponda 8 each, Avinasi, Hosdurg, Salem, Mettupalayam, Palakkad, Dharpuram, Kurudamannahil, Bodinaiackanur and Kannur 7 each, Sholavandan, H D Kote, Gobichettiplayam, Tiruchengode, Hunsur and Neyveli AWS 6 each, Vadaakancherry, Ketti, Aryankavu, Perinthalmanna, Vellankkara, PonnampetPvd, Varkala, Uthamamandalam, CIAL Kochi, Enamakkal, Chinnakalar, Konni, Surrug, Aravakurichi, Mudukulatur, Vandavasi, Kollam Rly, Angadipuram and Dharamapuri 5 each</td>
</tr>
<tr>
<td>10 Oct</td>
<td>Kunta and Kuppady 8 each, Chinnakalar and Shimoga 7 each, Basudevapur AWS and Bhagamandala 6 each, Kalasa, Long Islands, Krishnarajagiri and Mannarkad 5 each</td>
</tr>
<tr>
<td>11 Oct</td>
<td>Ichchapuram 24, Tekkali and Mahendragarh 23 each, R. Udaigiri and Mohana 22 each, Purushottampur 21, Palasa 20, Raigath 17, Nuvaguda ARG 16, Aska 15, Bhograi, Digha, Dighupahandi ARG and Balikuda ARG 14 each, Chhatrapur, Mandasa, Ranpur, Raghunathpur ARG and Sorada 13 each, Kendorpara, Nilgiri, Sompeta, NHGobindpur, Balasore and Kantapada ARG 12 each, Kaptipada ARG, Soro, Chandikhol ARG, Marsaghai ARG, Paradip and Pinbharnpur ARG 11 each, Pathapatnam, Contai, Alipinjal, Jagatsinghpur AWS, Basudevapur AWS, Gop, Korei ARG and Gopalpur 10 each, Bhananjgar, Tikabali, Sagar, Jaipur, Kujanga ARG, Madhabarinda, Odaugon ARG, Kalingapatnam, Betanagi ARG, Remuna ARG, Belagundu ARG, Tirtol ARG, Pattumambdi, Bhadrak AWS and Niali ARG 9 each, Raikia ARG, Kakatpur, Jagadhari, Nimpara, G Udaiagiri AWS, Puri, Nischintakolli ARG, Astaraniga ARG, Pipili, Jaleswar and Tangi 8 each, Contai, Banpur, Jagannath Prasad ARG, Krishnaprasad, Narsingpur, Balimundali, Banki ARG, Derabis ARG, Akhuapada, Salepur ARG, Bari ARG, Balipatna ARG, Iajpur, Kalinga, Bhubaneswar AP, Jenaupur, Nagayar and Garagar ARG 7 each, Bolagar ARG, Daitari, Cuttack, Dham nagar ARG, Mundali, Athgarh and Mahanga ARG 6 each, Daspalla, Gudari, Rajkanika, Mustafabad, Pathankot, Naraj, Bonth, Naraingarh, Khandapara, Baripada, Udala, Nandigram, Rajpura, Anandpur, Nagarcoil, Malakpur, Ranastalam, Brahmagiri AWS, Tirigira ARG and Alurna CWC 5 each</td>
</tr>
<tr>
<td>Date</td>
<td>Some representative amounts of rainfall in cm for October, November and December 2018 (5 cm and above)</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>12 Oct</td>
<td>G Udayagiri AWS 35, Kantapada ARG, Daringbadi and Kalinga 32 each, Raikia ARG and Banki ARG 28 each, Mohana 24, Sorada and Phiringia ARG 23 each, Ranipur 22, Baliguda 21, Harahanga, K Nuagaon ARG, Phulbani, Monghyr and Dasapalla 20 each, Pur, Satyabadi ARG, Tigiria ARG, Jagatsinghur AWS and Niali ARG 19 each, Bolagarh ARG 18, Jaipur, Aska, Banpur and Gania ARG 17 each, Tikarpura, Khagadia, Athgarh and Nirmapa 16 each, Odagao ARG, Narasinghpur, Bhanjnagar, Barnul, R.Udaigai, Nayagarh, Jagapur and Balipatna ARG 15 each, Taangi, Kotagarh, Krishnaprasad, Pathaputnam, Garadapur ARG, Curttack and Pakuria 14 each, Salepur ARG, Amrapara, Alipingal and Mahangu ARG 13 each, Parjang ARG, Madhabbarida, Talcher, Jagannath Prasad ARG, Gop, Ambadola, Koshangarh, Kendrapara and Pipili 12 each, Guidari, Balumidani, Mundali, Veeraghattam, Korei ARG, Marsaghai AWS, Samakhunta AWS, Ichchapuram, Kurupam, Hindol and Madanpur Rampur 11 each, Binjharpur ARG, Lanjigar, Nilgiri, Dhenkanal, Bari ARG, Sukinda, Khandapara, Kotuguda, Tirtol ARG, Danagadi ARG, Gunupur, Tekkali, Derabis ARG and Bhubaneswar AP 10 each, Nuagaon ARG, Ghatisila, Brahmagiri AWS, Banarpal ARG, Janapur, Naraj, Bonth, Balajipeta, Rajkishorenegar, Alappuzha, Angul, Baripara, Tihidi ARG and Maheshpur 9 each, Mandasa, Muniguda ARG, Namsai, Dhamnagar ARG, Chandanpur, Komarada, Sompara, Akhuapada, Jagagan, Palakonda, Rajkanika, Berhampur, Kantamal, Bhadrak AWS, Bhuban ARG, Raghunathpur ARG, Astaranga ARG, Barhiya and Sabour 8 each, Chendipadi, Purushottampur, Almuta Cwe, Balikuda ARG, Chandikhol ARG, Harichandanpur ARG, Khairamal, Athmalik, Boudhgarh, Narla ARG, Rayagada, Palasa, Balitar, Barigoriposi, Sori, Sonepur, Bhavani P., Bhagalpur, Rajmahal, Nawana, Pattamundai, Saantal ARG, Chandbali, Jyliyamma Valasa, Murarai, Ghatagao, Kamakhyangan, Anandpur and Basudeypur AWS 7 each, Gogri, Tarva ARG, Sagardighi, Kankadadpur ARG, Godda, Rengali, Belgaon, Mahendragarh, Kaptipada ARG, Kakatpur, Thakurkunda, Nakur and Chanchal 6 each, Katihar, Bijnor, Parbatta, Bolangir, Jamsolaghat, Kesinga ARG, Udala, Birmaharajpur ARG, Colgaon, Jangipur, Thakurdwara, Sirmari B.Pur, Sabroom, Betanati ARG, Kaniha ARG, Telkoi, Baghmar AWS, Williamagar, Nalhati, Garagubili and Dhampus 5 each</td>
</tr>
<tr>
<td>15 Oct</td>
<td>Betanati ARG 16, Digha 15, Kaptipada ARG, Rajghat, Contai and Bhograi 13 each, Danagadi ARG, Dhamnagar ARG, Balimulndi, Bonth and Tihidi ARG 11 each, Jaleswar, Renunna ARG and Kalaikunda 10 each, Thakurkunda and Karanja 9 each, Jajpur, Samakhunta AWS, Bangiriposi, Karingunj, Serchip (Hydro), Mahanga ARG, Anandpur, B P Ghat, Bari ARG, Balasore, NHS Gobindpur and Chandanpur 8 each, Baripara, Nilgiri, Udala, Sukinda, Ghatagao and Jamsolaghat 7 each, Canning Town, Swam -Patna, Basudeypur AWS, Nawana, Astaranga ARG, Salepur ARG and Raghunathpur ARG 6 each, Soro, Bashirhat, Annupurnaghat, Durgachak, Daitari, Harichandanpur ARG, D.P.Ghat, Binjharpur ARG, Nischintakoli ARG, Paradip, Kendrapara, Jenapur, Korei ARG, Jagatsinghur AWS, Jupiship, Passigath, Sabroom, Gop and Balikuda ARG 5 each</td>
</tr>
<tr>
<td>20 Oct</td>
<td>Bestarvijepeta 11, Thandupuzha and Pechiparai 10 each, Cherrapunj 9, Konni and Cherrapunj (Rkm) 8 each, Kurudammnill, Udayagiri and Paren 7 each, Mani 6, Thiruvananthapuram and Chodavaram 5 each</td>
</tr>
<tr>
<td>25 Oct</td>
<td>BAYyaram 10, Mahabubabad, Maheswar, T Narasipur and Garla 9 each, Manugu and Kollegal 8 each, Pathapatnam, Sathanur Dam and Markapur 7 each, Alappuzha, Ernakulam South, Valparai and Mchalilpatnam 6 each, Denkanikottai, Barur, Paramathivelur, Bhagamandal, Vaniyambadi, Srivilliputhur, Pochampalli, Sivaganga, Malur, Polur, Bantw, Ottapalam, Krishnarajapur, Anekal, Dornmak, Nilambur, Vellore and Pappireddipatti 5 each</td>
</tr>
<tr>
<td>5 Nov</td>
<td>Amalapuram 8, Chodavaram 7, Velamanchili 6, Sukkoon, Vizianagaram, Haveri APmc and Mannarkkad 5 each</td>
</tr>
<tr>
<td>20 Nov</td>
<td>Hagaribommanahalli 11, Davanagere 9, Kampili 8, Gooty, Chennai AP, Minicoj, Sandur and Virinjipuram AWS 7 each, Pavagada, Tiptur, Long Islands, Koppal PTO, Santhebennur, Davanagere PTO, Settur, Molakalmuru, Talikote, Kanakal, Ulundurpet and Tavarahara 6 each, Pakala, Nambalupilikunta, Palanmen, Mudgal, Kadadi, Golkonda, Bengaluru CO, Anekal, Hut Bay, Chittoor, Kuilgli and K Aghrawanjumura 5 each</td>
</tr>
<tr>
<td>5 Dec</td>
<td>Sira and Srivilliputhur 11 each, Vadakkancherry and Karipur 9 each, Ernakulam South, Hiriyur HMS, Bellur and Vaikom 7 each, Ottapalam, Bukkapatna, Kayamkulam, Thiruvananthapuram, Kosha and Kollupur 6 each, Kovalpatti, Cherthala, Vellanikara, Lingadahalli, Subramanya, Mangan, Kurudammnill and Neya yattinka 5 each</td>
</tr>
<tr>
<td>10 Dec</td>
<td>Periyakulam 16, Piravam 12, Periyainaiickenplayam 10, Mahe and Cherthala 9 each, Quilandi, Kannur, Vadakara and Alathur 8 each, Kushalnagar, Chennai AP, Perinthalmanna and Mavelkara 6 each, Thirthala, Kollamkode, Nilambur, Enamakkal, Sankaranikoi and Kochi AP 5 each</td>
</tr>
<tr>
<td>20 Dec</td>
<td>Virudhunagar 12, Periyur and Nanguneri 9 each, Arumannaipudur and Periyakulam 7 each, Bhagamandula 6, Manimuthu U U, Mylaudy, Quilandi, Thodupuzha, Srivilliputhur, Peermade TO, Nagarcoel, Ambasamudram and Rameswaram 5 each</td>
</tr>
<tr>
<td>25 Dec</td>
<td>Chidambaram and Vanur 9 each, Anaikaranchatram (Kollidi) 8, Pechiparai, Sathyamangalam and Marakkanam 7 each, Tiruchendur, Car Nicobar and Thenkasi 6 each, Kurudammnill, Sirkali, R.S.Mangalar and Satankulam 5 each</td>
</tr>
<tr>
<td>30 Dec</td>
<td>CIAL Kochi 7, Aryankavu, Manimuthu U U and Aluva PWD 6 each, Nanguneri 5</td>
</tr>
<tr>
<td>1 Jan</td>
<td>Domokanda and Punalur 7 each, Assifabad 6, Pechiparai, Naryankhand, Naryankhand (ARG) and Gandhari 5 each</td>
</tr>
<tr>
<td>Date</td>
<td>Some representative amounts of rainfall in cm for October, November and December 2018 (5 cm and above)</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>25 Oct</td>
<td>Tiruchendur 8, Thoothukudi, Vedaranimmay, Thoothukudi Port AWS and Ottapadiram 6 each, Noothankal 5</td>
</tr>
<tr>
<td>26 Oct</td>
<td>Rameswaram 7, Pamban 5</td>
</tr>
<tr>
<td>27 Oct</td>
<td>Nil</td>
</tr>
<tr>
<td>28 Oct</td>
<td>Kamalpur 10, Ghurama 8, Dharmanagar/Panisagar 7, Lengpui and Kailashahar 6 each, Silchar 5</td>
</tr>
<tr>
<td>29 Oct</td>
<td>Nil</td>
</tr>
<tr>
<td>30 Oct</td>
<td>Nil</td>
</tr>
<tr>
<td>31 Oct</td>
<td>Ennore AWS, DGP Office, Mahabalipuram and Ponneri 5 each</td>
</tr>
<tr>
<td></td>
<td>Puzhal ARG 11, Kelambakkam 10, Pululur, Periyanaickenpalayam, Perundurai and Cuddalore 9 each, Mylavadumpaagria 8, Madavaras AWS and Avinasi 7 each, Peraiyur, Konni, Ennore AWS, Red Hills and Taramani ARG 6 each, Vedaranimmay, Satyabarna Uty ARG, Sivakasi, Mahabalipuram and Thodupuzha 5 each</td>
</tr>
<tr>
<td>1 Nov</td>
<td>Vedaranimmay 15, Nagapattnam 14, Thiruthuraipoondi 13, Mayiladuthurai 9, Tiruvarur 8, Karkilal, Nallilam, Rameswaran, Nagarai and Parangipetipaitai 7 each, Pamban, Kandukur and Madukkur 6 each, Sirkali, Pattukottai, Tissa, Kaveli, Pollachi, Pakala, Chidambaram, Anaikaranchathram (Kollidi) and Kodavalasal 5 each</td>
</tr>
<tr>
<td>2 Nov</td>
<td>Manimutharu U 29, Satankulam 22, Papanasam 16, Tiruchendur 11, Neyyattinkara 10, K.M. Koil 9, Thiruvanantapuram AP 8, Thiruthuraipoondi, Maniyachi, Srivaiakuntam and Nallilam 7 each, Jayankondam, Valangaiman, Thoothukudi, Nedumangad, Karkilal, Shahim AGRO, Kaikalur, Aduthurai AWS, Cheranmahadevi, Srinagar AGRO AWS, Thiruvanantapuram, Nanguneri, Thoothukudi Port AWS and Harran AWS 6 each, Sirkali, Parangipetipattai, Kumbakonam, Thucklay, Thirividaimaruthur, Vedaranimmay, Rambagh AWS, Srinagar, Needamangalam, Colachel, Palhalom, Srinagar IAF, Pandavaiyar Head, Nagapattnam, Tiruvurar and Ottapadiram 5 each</td>
</tr>
<tr>
<td>3 Nov</td>
<td>Papanasam 15, Anantnag, Quazigund, Palhalom and Srinagar IAF 7 each, Banihal, Manimutharu U U, Coonoor and Kukernag 6 each, Tirumangalam, Kannur, Madurai AP and Jospham 5 each</td>
</tr>
<tr>
<td>4 Nov</td>
<td>Papanasam 15, Anantnag, Quazigund, Palhalom and Srinagar IAF 7 each, Banihal, Manimutharu U U, Coonoor and Kukernag 6 each, Tirumangalam, Kannur, Madurai AP and Jospham 5 each</td>
</tr>
<tr>
<td>5 Nov</td>
<td>Akole 15, Vadgaon Maval 6, Pen, Chipplun and Tutting 5 each</td>
</tr>
<tr>
<td>6 Nov</td>
<td>Mahabaleshwar and Tutting 5 each</td>
</tr>
<tr>
<td>7 Nov</td>
<td>Nil</td>
</tr>
<tr>
<td>8 Nov</td>
<td>Nagapattinam 8, Satankulam 7, Rameswaran 6, Vedaranimmay and Srivaiakuntam 5 each</td>
</tr>
<tr>
<td>9 Nov</td>
<td>Sirkali 7, Hut Bay, Port Blair and Nallilam 5 each</td>
</tr>
<tr>
<td>10 Nov</td>
<td>Long Islands 14, Maya Bandar 10, Port Blair 9, Mavelikara and Hut Bay 5 each</td>
</tr>
<tr>
<td>11 Nov</td>
<td>Maya Bandar 7, Long Islands 6</td>
</tr>
<tr>
<td>12 Nov</td>
<td>Long Islands 10, Port Blair 5</td>
</tr>
<tr>
<td>13 Nov</td>
<td>Nil</td>
</tr>
<tr>
<td>14 Nov</td>
<td>Nil</td>
</tr>
<tr>
<td>15 Nov</td>
<td>Gohar 5</td>
</tr>
<tr>
<td>16 Nov</td>
<td>Thiruthuraipoondi and Muthupet 17 each, Adirampattinam 16, Peravurani, Pattukottai and Neyveli AWS 14 each, Vinudachalam 12, Chengalpattu 11, Cuddalore 9, Madukkur, Arantangi and Vandavasi 8 each, Srimushnam, Nageroil, Uthiramur, Valinokkam ARG, Orthanad, Needamangalam, Sethiathoipe, Thucklay, Puducherry and Tozhudur 7 each, Nagapattinam, Parangipetipattai, Kodikanal, Valangiaman, Jayankondam and Kancheepuram 6 each, Chidambaram, Karkilal, Varkala, Alangudi, Sendurai, Kanyakumari, Eranjel, Ariyalur, Rameswaran, Kodavalasal, Pamban, Mayiladuthurai, Thoothukudi, Thanjavur and Tutrivyayara 5 each</td>
</tr>
<tr>
<td>17 Nov</td>
<td>Kozha 28, Piravam 19, Sivaganga 17, Thodupuzha 15, Kodikanal 14, Cherthala and Munmar KSEB 12 each, Kumarakom 11, Idikkul and Thammapattip 10 each, Vaikom, Nilakottai, Iluppur, Periyakulam, Bodinaickanur and Mylndernumpaaraagri 9 each, Kottayam and Tirupatthuart 8 each, Kandukur, Peermead TO, Aswaraopeta, Chinnakalar, Vadipatti and Gudivada 7 each, Andipatti, Aswaraopet AP, Kamatchhipuram, Dindigul, Chatrapatti (Dandachatra) and Gudalur 6 each, Aranmanaiapurud, Ernakulam South, Sholavanad, Karkiludi, Tutting, Valparai, Perumpavur, Vinjamur, Natham, Muppatty and Valparai Taluk Office 5 each</td>
</tr>
<tr>
<td>18 Nov</td>
<td>Srungavarapukota 8, Narasampet 6</td>
</tr>
<tr>
<td>19 Nov</td>
<td>Pavagada and Nilanga 7 each, Perumpurav, B Durga, Mettupalayam, Dabholim (Goa) and Hubballi 6 each, Davanagere, Kurudamannil, Marmugoda, Konni and Vellanikkara 5 each</td>
</tr>
<tr>
<td>20 Nov</td>
<td>Shencottah 8, Vaikom 7, Manimutharu U U 6, Chengannur, Kayamkulam Agri, Piravam, Pamban, Mohol, Dahiwadi Man, Papnasam, Tiruchendur, Thiruvanantapuram AP, Rameswaran and Indi 5 each</td>
</tr>
<tr>
<td>Date</td>
<td>Some representative amounts of rainfall in cm for October, November and December 2018 (5 cm and above)</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>21 Nov</td>
<td>Ottapalam 9, Karaikal and Trangambadi (Or Tranqueb) 7 each, Thudupuzha 6, Vedaraniyam, JavaliMedha, Vaikom, Chidambaram, Dahiwadi Man, Parangipettai, Valangaiman, Adirampattinam, Chennai AP, Kumbakonam, Kochi AP and Chembarambakkam 5 each</td>
</tr>
<tr>
<td>22 Nov</td>
<td>Gudur 17, Sullurpeta 15, Cholavaram and Madavaram AWS 12 each, Vanur, Tirupathi AP, Tada and Red Hills 11 each, Ponneri 10, Rapur, Chennai city, DGP Office, Marakkanam, Tindivanam, Chennai AP, Panruti and Anna Uty ARG 9 each, Thamaraipakkam, Venkatagiri and Neyveli AWS 8 each, Taramani ARG, Nagari, Pallipattu, Atmakur and Chengalpattu 7 each, Mahabalipuram, Tiruttani, Madurantaham, Vilupuram, Puducherry, Gingee, Samayapuram, Cheyyur, Anna University and Poondi 6 each, Nellore, Kelambakkam, Vandavasi, Chittoor, Palasamudram, Pakala, Tozhudur and Tiruvallur 5 each</td>
</tr>
<tr>
<td>23 Nov</td>
<td>Chengalpattu 18, Madurantaham 14, Mahabalipuram 10, Uthiramerur, Vandavasi and Sullurpeta 9 each, Tada, Marakkanam, Parangipettai, Vanur, Gingee and Tindivanam 8 each, Sripurumbudur, Kancheepuram and Arani 7 each, Avinasi, Tirupathi AP, Palur, Vaikom, Cuddalore, Cholavaram and Red Hills 6 each, Kalavai AWS, Neyveli AWS, Tiruvannamalai, Ayikudi, Tambaram, Sirkal, Cheyur, Thamaraipakkam, Sankarapuram, Manimuthuarm U U, Puducherry, Anaikaranchatram (Kollid), KVK Kattukuppam ARG, Perumpavur and Vellore 5 each</td>
</tr>
<tr>
<td>24 Nov</td>
<td>Rameswaram 23, Valangaiman 19, Tiruvur and Nagapattanam 17 each, Pamban, Needamangalam and Kumbakonam 15 each, Kodavasal 14, Pandavaiyar Head 12, Mannargudi and Karaikal 11 each, Ariyalur, Trangambadi (Or Tranqueb), Madakkur and Nannilam 10 each, Chettikulam, Thiruvidaimaruthur, Perambular and Tozhudur 9 each, Chinnakalar and Tiruvaiyaru 8 each, Pattukottai, Valparai Taluk Office, Adirampattinam, Jayankondam, Thirurthuraipoondi and Sendurai 7 each, Mayiladuthurai, Manorji, Thirumurur, Srimushnam, Papanasam, Laligudi, Perinthalamanna, Pullambadi and Perungalur 6 each, Mangaluru, Samayapuram, Venbavur, Perumpavur, Parangipettai, Ulundupet, Aduthurai AWS, Kottayam, Nilambur, Pudur CMS, Angadipuram, Sethiathope, Vaikom, Sattur, Thanjavur, Anaikaranchatram (Kollid), Sirkali, Harur, Venkatagiri and Orathanad 5 each</td>
</tr>
<tr>
<td>25 Nov</td>
<td>Kottayam 8, Bhoopathandy, Mannargudi and Chengannur 5 each</td>
</tr>
<tr>
<td>26 Nov</td>
<td>Amini Divi 24, Manjeri 6</td>
</tr>
<tr>
<td>27 Nov</td>
<td>Nil</td>
</tr>
<tr>
<td>28 Nov</td>
<td>Nil</td>
</tr>
<tr>
<td>29 Nov</td>
<td>Thirurthuraipoondi 10, Anaikaranchatram (Kollid) 7, Chidambaram AWS and Sirkali 6 each, Chidambaram, Parangipettai, Sethiathope and Mayiladuthurai 5 each</td>
</tr>
<tr>
<td>30 Nov</td>
<td>Kumbakonam 8, Rameswaram 7, Thiruvidaimaruthur and Aduthurai AWS 6 each, Tirukkattupalli, Trangambadi (Or Tranqueb), Grand Anaicut, Kodavasal, Pamban, Puducherry and Coonoor 5 each</td>
</tr>
<tr>
<td>1 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>2 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>3 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>4 Dec</td>
<td>Ponneri 13, Ennore AWS 10, Cholavaram 8, Kelambakkam 7, Red Hills, Karaikal and Chennai AP 5 each</td>
</tr>
<tr>
<td>5 Dec</td>
<td>Cholavaram 8, Gudur 6, Car Nicobar IAF and Thamaraipakkam 5 each</td>
</tr>
<tr>
<td>6 Dec</td>
<td>Kavali 11, Nellore and Marakkanam 8 each, Virudachalam 7, Banavasi, Sullurpeta and Shikaripur 5 each</td>
</tr>
<tr>
<td>7 Dec</td>
<td>Irikkur 5</td>
</tr>
<tr>
<td>8 Dec</td>
<td>Long Islands 16</td>
</tr>
<tr>
<td>9 Dec</td>
<td>Hut Bay 5</td>
</tr>
<tr>
<td>10 Dec</td>
<td>Hut Bay 11</td>
</tr>
<tr>
<td>11 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>12 Dec</td>
<td>Long Islands 5</td>
</tr>
<tr>
<td>13 Dec</td>
<td>Kaithal 7, Dahegaon 5</td>
</tr>
<tr>
<td>14 Dec</td>
<td>Hakimpet 9, Shamirpet, Cherthala, Kamalapur, Hyderabad and Gulbarga 5 each</td>
</tr>
<tr>
<td>15 Dec</td>
<td>Car Nicobar 9, Car Nicobar IAF 7</td>
</tr>
<tr>
<td>16 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>17 Dec</td>
<td>Vijaywada AP 24, Gudivada 10, Nuzvid, Aswarapoeta, Avanigada, Sathupalle, Vijaywada and Aswarapoet AP 9 each, Mulakalapalle, Chandrugonda, Enkuru and Eluru 8 each, Kothagudem, Julurpad, Manuguru, Palawancha, Kaikulur, Chintalapudi, Repalle, Burgampadu, Amalapuram and Tenali 7 each, Kukunoor, Velaipad, Tiruvuru, Pinapaka, Tolland, Mangalagiri, Vararamachandrapur, Tekulapalle, Madanpur Rampur and Kothagudem 6 each, Kunavaram, Machilipatnam, Aswapuram, Sinapali ARG, Polavaram, Venkatapuram, Tadepalligudem, Boden ARG, Bheemavaram, Dornakal, Yellandu, Konijerla, Bapatla and Koyyalaragudem 5 each</td>
</tr>
</tbody>
</table>
TABLE 5 (Contd.)

<table>
<thead>
<tr>
<th>Date</th>
<th>Some representative amounts of rainfall in cm for October, November and December 2018 (5 cm and above)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 Dec</td>
<td>Araku Valley and Salur 13 each, Amalapuram and Bheemunipatnam 12 each, Visakhapatnam, Bondapalle, Mentada and Ranastalam 11 each, Gajapatinagar, Kalingapatnam, Gurudia ARG, Padampur and Kirmira ARG 10 each, Cheepurupalle, Bolangir, Merakamudidum, Lahunipara, Thelam, Nellimarla, Tenas, Bobbili, Garividi, Nuagada ARG, Bamra ARG, Banaigarh AWS, Jamankira, Rajangpur and Jamshedpur AP 9 each, Deogaon, Burla ARG, Kuchinda, Hirakud, Jhumpura, Joda ARG, Ambabhona, G Udayagiri AWS, Reamal, Pottangi, Vizianagaram, Lakhanpur ARG, Binika, Barghar, Chodavaram, Panposh, Bapalli ARG, Jharsuguda AP, Bati ALI, Paikmal and Champua 8 each, Laikera, Pusapatrenga, Seethanagaram, Sambalpur, Gaisilel ARG, Kakinada, Chakradharpur, Ullunda ARG, Paralakkemundi, Gantyada, Chaibasa, Chintapatlle, Dunguripalli, Deogarh, Parvathipuram, Balajipeta, Keongjhargarh, Rainakhol, Tun, Paderu, Sonepur, Garubulili, Sringavarapukota, Hemgiri, Bijepur, Atabira ARG and Lanjigarh 7 each, Tikarpara, Birmaharajpur ARG, Naktideul, Jharbandh ARG, Navapara, Sohela, Vepada, Veeraghottam, Kantamal, Balod, Ichchapuram, Harabhanga, Narsipatnam, Denkada, Jujumura ARG, Torpa, Kurupam, Tiring, Visakhapatnam AP, Bargaon, Saintala ARG, Tarva ARG, Bilaspur, Muniguda ARG, Ranchi AP, Koraput, Turekela, Pathapatnam, Khrakhol ARG, Anakapalle AP, Sarangar, Madanpur Rampur and Rayagada 6 each, Khairamal, Rampur, Anakapalle, Tilagarh, Angul, Janjgir, Gopalpur, Yelamanchil, Ambodola, Tekkali, Barkote, Bhanjanagar, Dhamtari, Daspalla, Banarpal ARG, Raika ARG, Rairangpur, Peddapuram AP, Joshipur, R.Udaigiri, Dondholaha, Chandahandi ARG, Champga, Pathalgaon, Mandar, Mana AP, Thollada, Jamshedpur, Hindol, Sorada, Raipur, Jhapumagar, Kashi nagar, Car Nicobar IAF, Aska, Peddapuram, Nayagar, Odagaon ARG, Kharidwar, JiyamammaValasa, Kolabira ARG, Kunavaram, Similiguva AWS, Gunupur, Madhira, Dharmagarh ARG, Digapahandi ARG, Jaipatna, Pallahara, Jaridih, Madhabarida, Tenali, Deobhog, Phulseria, Mangalagiri, Belagundla ARG, Kesinga ARG and Barmul 5 each</td>
</tr>
<tr>
<td>19 Dec</td>
<td>Tawang AWS 6, Paren Nsmda AWS, Car Nicobar and Ong Pangkong Nsmda AWS 5 each</td>
</tr>
<tr>
<td>20 Dec</td>
<td>Long Islands 8</td>
</tr>
<tr>
<td>21 Dec</td>
<td>Maya Bandar 6</td>
</tr>
<tr>
<td>22 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>23 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>24 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>25 Dec</td>
<td>Perumpavur 7</td>
</tr>
<tr>
<td>26 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>27 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>28 Dec</td>
<td>Nil</td>
</tr>
<tr>
<td>29 Dec</td>
<td>Vaikom and Kozhikode 5 each</td>
</tr>
<tr>
<td>30 Dec</td>
<td>Manimutharu U U 7</td>
</tr>
<tr>
<td>31 Dec</td>
<td>Nil</td>
</tr>
</tbody>
</table>

of the 9 subdivisions in this region 7 were large deficient and 2 remained deficient.

An anomalous anticyclone over southern parts of Peninsula in the lower levels hindered rainfall activity resulting in three core regions of this monsoon having large deficiency, Rayalaseema at -81%, Tamil Nadu & Puducherry -76% and South Interior Karnataka at -63% of LPA.

3.3.3. Temperature

Cold wave conditions manifested from mid December from West Rajasthan and prevailed for a few days at isolated places over sub-divisions of North and Central India. In the last week of the month the cold wave spread to major parts of Northwest India and some parts of Central India and isolated incidences over Peninsular India. Along with spatial extension there was also intensification of the cold waves at the end of the season and these regions also experienced severe cold wave conditions for 1-2 days during this period. Frequency of cold wave conditions was highest over Rajasthan, Saurashtra & Kutch and West Uttar Pradesh divisions.

Cold wave conditions prevailed at isolated places for 2 days over Madhya Pradesh in the second half of the month. The lowest minimum temperature recorded was -1.0 °C at Hissar (Haryana) and Bhilwara (west Rajasthan) on 26 and 29 December, respectively.

Minimum temperatures were normal to below normal over most parts of India except over parts of peninsular


India in the first fortnight of the month and some sub divisions of East and northeast India in the third week of the month. In the second fortnight minimum temperatures dropped to appreciably below normal and in the last week some divisions recorded markedly below normal temperatures.

3.3.4. Damages associated with the Disastrous weather events

As per media reports, Severe Cyclonic Storm ‘Phethai’ claimed nine lives and forced evacuation of 20,000 people in Andhra Pradesh and 11,600 people in Odisha. Over 10.3 lakh hectares of agricultural crops, 10,000 hectares of horticultural crops and 12,000 mobile towers were damaged in Andhra Pradesh, East and West Godavari were the worst hit. Winds that gusted up to 85-90 kmph uprooted electric poles and trees in East Godavari, disrupting power supply.

The other weather related disasters that occurred were due to dense fog, which lead to very low visibility in North India, which claimed 16 lives and left 33 injured in different road accidents.

Appendix

Definitions of the terms given in ‘Italics’

(A) Rainfall

<table>
<thead>
<tr>
<th>Percentage departure from normal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large excess</strong></td>
</tr>
<tr>
<td><strong>Excess</strong></td>
</tr>
<tr>
<td><strong>Normal</strong></td>
</tr>
<tr>
<td><strong>Deficient</strong></td>
</tr>
<tr>
<td><strong>Large deficient</strong></td>
</tr>
</tbody>
</table>

No Rain | –100%

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

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy rainfall</td>
<td>6.5-11.5 cm</td>
</tr>
<tr>
<td>Very heavy rainfall</td>
<td>11.6-20.4 cm</td>
</tr>
</tbody>
</table>

Extremely heavy rainfall | 20.5 cm or more

(B) Monsoon activity

(i) Southwest monsoon

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

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

(ii) Northeast monsoon

- **Vigorous**: Rainfall exceeding 4 times the normal with at least two stations reporting rainfall more than or equal to 5 cm in coastal Tamil Nadu and south coastal Andhra Pradesh and 3 cm elsewhere in the northeast monsoon region. Rainfall in that sub-division should be fairly widespread or widespread
Rainfall more than 1½ to 4 times the normal, with at least two stations reporting rainfall more than or equal to 3 cm in coastal Tamil Nadu and south coastal Andhra Pradesh and 2 cm elsewhere in the northeast monsoon region. Rainfall in that sub-division should fairly widespread or widespread.

<table>
<thead>
<tr>
<th>Active</th>
</tr>
</thead>
</table>

(C) Temperatures

(i) Maximum / Day temperature

<table>
<thead>
<tr>
<th>Markedly above normal</th>
<th>When departure from normal is +5 °C or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appreciably above normal</td>
<td>When departure from normal is +3.1 °C to +5.0 °C</td>
</tr>
<tr>
<td>Above normal</td>
<td>Departure from normal is +1.6 °C to +3.0 °C</td>
</tr>
<tr>
<td>Normal</td>
<td>When departure from normal is +1.5 °C to −1.5 °C</td>
</tr>
</tbody>
</table>

(ii) Minimum / Night temperature

Based on the revised criteria which came into practice with effect from 2016, cold waves are declared based on the actual minimum temperatures. Cold wave is considered when the minimum temperature of a station is 10 °C or less for plains and 0 °C or less for hilly regions. Also to declare cold wave, the criteria should be met at least in 2 stations in a met sub-division for at least 2 consecutive days.

| Severe cold wave conditions | When the negative departure of minimum temperature from normal is more than 6.4 °C or when the actual minimum temperature is ≤2 °C over the plains. |

Cold wave conditions

When the negative departure of minimum temperature from normal is 4.5 °C to 6.4 °C or when the actual minimum temperature is ≤4 °C over the plains.

For stations located over the coastal areas, when the minimum temperature departure is −4.5 °C or more, ‘Cold Wave’ may be described if the actual minimum temperature is 15 °C or less.

Cold day to severe cold day conditions

When the minimum temperature is less 10 °C for plains and 0 °C or less for hilly regions. Cold day may be described if the departure of maximum temperature is −4.5 °C to −6.4 °C and severe cold day when it is more than 6.4 °C.

| Markedly below normal | When departure from normal is −5 °C or less |
| Appreciably below normal | When departure from normal is between −3.1 °C to −5.0 °C |
| Below normal | Departure from normal is −1.6 °C to −3.0 °C |
| Normal | Departure from normal is −1.5 °C to +1.5 °C |