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A meso-scale study of unusually heavy rainfall over south Kerala

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सार — केरल राज्य के त्रिवेन्द्रम में 17-18 अक्तूबर 1964 को गर्ज के साथ आंधी सहित, असामान्य रूप से भारी वर्षा (40.10 से. मी.) हुई वर्षा का मेसो-स्केल अध्ययन किया गया है। जिससे पता चलता है कि 17 अक्तूबर की रात्रि को त्रिवेन्द्रम के पार घूमता हुआ एक छोटा सा भ्रमिल था जिसके कारण असामान्य रूप से भारी वर्षा हुई। इसके अलावा यह हो सकता है कि पार्वतिकी ने पोनमुडी में इस अवस्थिति को और प्रबल बना दिया हो जहां पर 10 कि. मी. की दूरी पर 40.64 से. मी. वर्षा हुई। इस प्रकार निम्न स्तर का मेसो-स्केल भ्रमिल के विद्यमान होने और ऊपरी क्षोभमंडल में पवन के अचानक प्रबल हो जाने से त्रिवेन्द्रम में प्रचंड गर्ज के साथ आंधी के विकास के लिए अनुकूल स्थितियां उत्पन्न हुई। अधिकतम वर्षा के क्षेत्र में इस भ्रमिल के पथ का अनुगमन किया।

ABSTRACT. On 17-18 October 1964 unusually heavy rainfall (40.10 cm) occurred in association with a thunderstorm at Trivandrum in Kerala State. A meso-scale study of the rainfall is attempted which shows a small vortex travelling across Trivandrum on the night of 17 October and causing unusually heavy rainfall. The orography might have further accentuated the situation at Ponmudi, where 40.64 cm rainfall at a distance of 10 km occurred. Thus, existence of a low level meso-scale vortex & sudden strengthening of winds in upper troposphere provided favourable conditions for development of severe thunderstorm activity over Trivandrum. Region of maximum rainfall followed the track of this vortex.

1. Introduction

In the night of 17 October 1964 at 2228 IST heavy continuous rain started over Trivandrum and at 2320 IST heavy thunderstorm also commenced which lasted up to 0830 IST thus causing 40.10 cm of rain with an average rate of rainfall around 4.5 cm/hr. According to press reports, widespread damage to life and property occurred and public services were dislocated. The intensity of the heavy rain is apparent from the hyetogram (Fig. 1) of Trivandrum for 18 October 1964. Deniel and Subramanian (1966) have also discussed this heavy rainfall situation. However, author is now attempting a meso-scale study of this unusual heavy rainfall with reference to the synoptic situation and vertical structure of the atmosphere preceding this event over Trivandrum.

2. Discussion of data

2.1. Synoptic situation at 12 UTC of 17 October (Fig. 2) shows a very small low pressure area near and over Trivandrum. It can also be seen from the 24 hours pressure changes over Trivandrum (Fig. 3) indicating steady fall in pressure values after 18 UTC of 16 October, with a maximum drop of 2.5 hPa at 18 UTC of 17 October, when the thunderstorm commenced over Trivandrum. Thereafter it had a rising trend and almost filled up by 0300 UTC when the thunderstorm ceased. The low pressure area moved northeastwards first slowly and after 18th rapidly.

2.2. Divergence at 12 UTC of 17 October for 1, 2, 3, 5, 7, 10, 15 and 20 thousands feet as calculated by finite differences (Bellamy 1949), despite its limitations, show strong convergence up to 500 hPa at and near Trivandrum. Divergence charts for 3000, 5000 & 10,000, 20,000 ft for 12 UTC of 17 October are shown in Figs. 4 (a-d). 200 hPa field became strongly divergent which supported outflow at higher levels and this helped in the development of intense convective clouds. Divergence chart for 3000 ft for 00 UTC of 18 October (Fig. 5a) shows line of strong convergence north of Trivandrum while divergence chart of 00 UTC at 3000 ft of 19 October (Fig. 5b) shows the area north of Trivandrum all filled up with divergence field and existence of convergence near to Trivandrum but towards south. A thunderstorm occurred at Trivandrum at 00 UTC of 19 October for about 2 hours. This caused heavy rainfall of 20 cm at Ponmudi for the 2nd successive day possibly in association with orography there. The earlier convergence area appear to have moved northeastwards on 3000 ft chart for 00 UTC of 19 October.

2.3. The tephigram for Trivandrum for 12 UTC of 17 October (not shown) shows strong conditional instability once a small trigger is made available which is presumably supplied by this small low pressure area associated with low level meso-scale vortex over Trivandrum and neighbourhood.

Vertical time-section chart for Trivandrum (Fig. 8) from 15 to 20 October 1964 reveals that the vortex

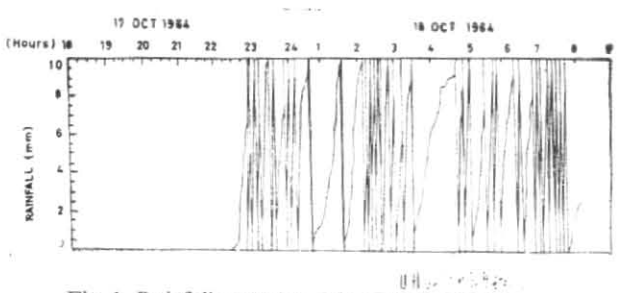


Fig. 1. Rainfall record at Trivandrum observatory

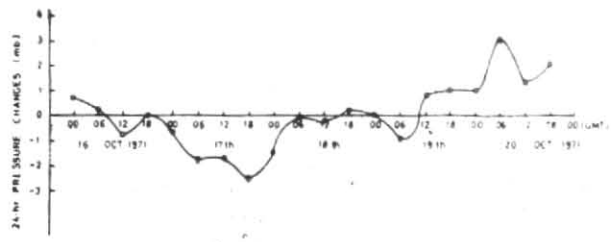


Fig. 3. Pressure changes chart

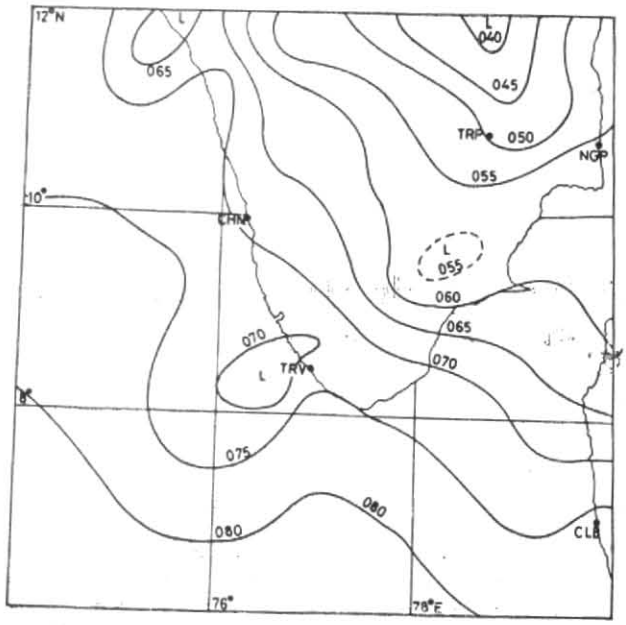
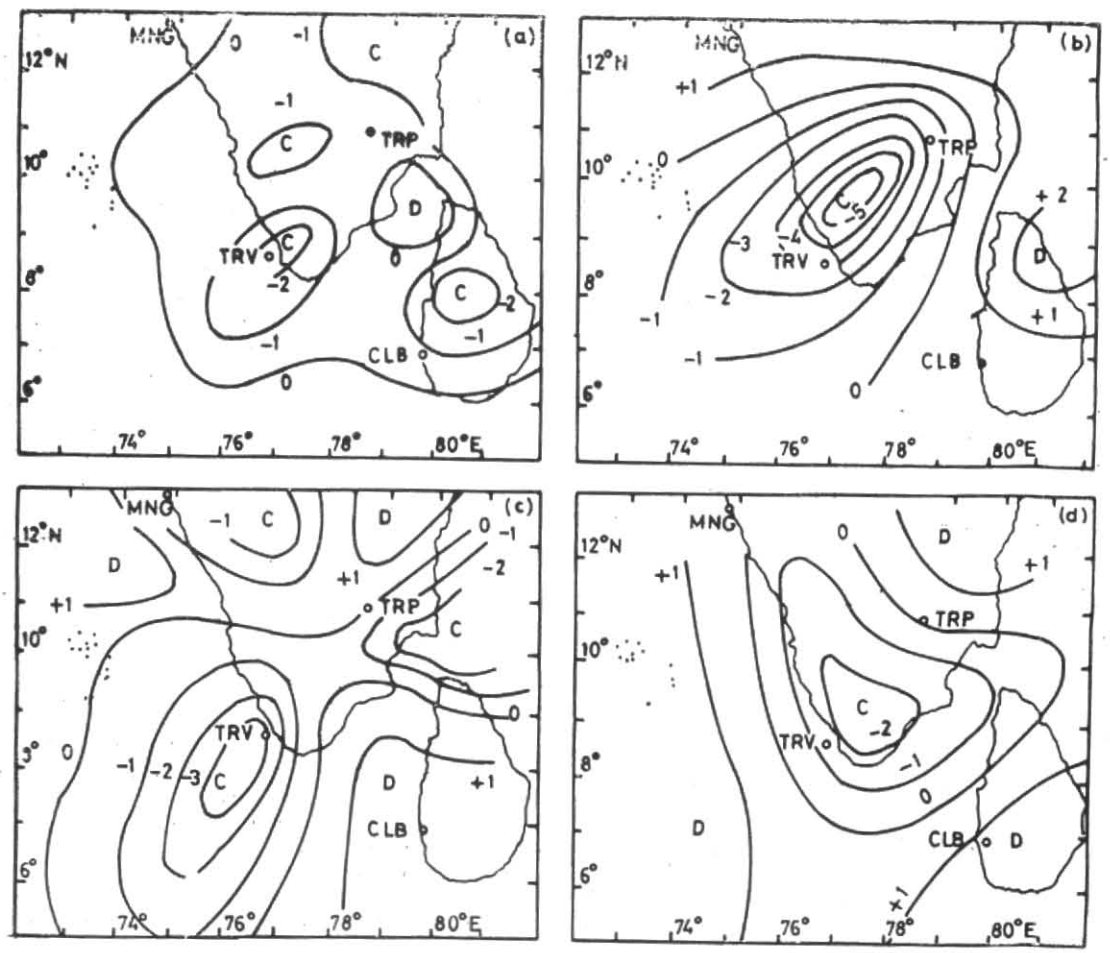
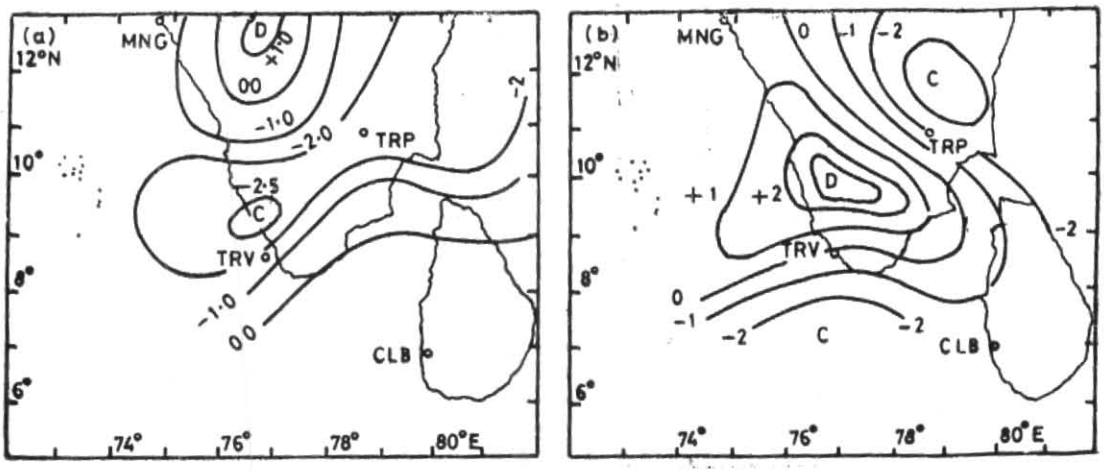


Fig. 2. Sea level chart of 17 October 1964 at 12 UTC



Figs. 4(a-d). Divergence charts at 12 UTC of 17 October 1964 for : (a) 3000 ft, (b) 5000 ft, (c) 10,000 ft and (d) 20,000 ft



Figs. 5 (a & b). Divergence chart at 00 UTC of : (a) 18 October 1964 and (b) 19 October 1964 at 3000 ft

at low level approached Trivandrum on 17th afternoon. The fall in contour values persisted to about 300 hPa and was associated with rise in contour heights at 200 hPa and above. The 00 UTC ascent of 18 October was not available due to heavy rain and thunderstorm but it is clear that such a situation lasted only for a few hours and by 12 UTC of 18 October the contour heights were showing a rising trend. It is also clear that the winds over Trivandrum became westerly up to 300 hPa by 12 UTC of 17 October. These westerlies quickly fell down to 700 hPa level by 12 UTC of 18 October and to 850 hPa by 00 UTC of 19 October. It is also seen that the easterlies over Trivandrum at 200 hPa strengthened from 15 kt at 00 UTC to 45 kt at 12 UTC of 17 October and continued so up to 00 UTC of 19 October and decreased progressively afterwards.

2.4. Temperatures at 12 UTC on 17 October 1964 registered a rise over those of 00 UTC up to 850 hPa and then slight fall at 700 and 500 hPa and warming thereafter till again at 200 hPa onwards temperatures were falling as compared to 00 UTC of same day at corresponding levels (Fig. 8). However, the situation was changed at 12 UTC of 18 October. When temperatures fell up to 850 hPa and registered a steady rise 500 hPa onwards at all levels which might have been, perhaps, due to the release of latent heat of condensation at higher levels on account of heavy rainfall. However, at 00 UTC of 19 October, a sharp fall in temperatures at the corresponding levels was recorded as compared to 12 UTC of 18 October.

The vertical time-section of Minicoy (not shown) indicates sudden rise in westerlies at 00 UTC of 17 October up to 400 hPa and further strengthening of these winds by 12 UTC. Easterlies on 12 UTC of 17 October over Minicoy weakened at 300 and 200 hPa significantly since last 24 hours while the easterly at 150 hPa shows a rise from 15 to 50 kt during the same period. This strengthening of westerlies in lower and middle tropospheric levels and strengthening of easterlies at higher tropospheric levels show temporary strengthening of the monsoon in the area on 17th afternoon.

2.5. *Rate of precipitation*

Considering 12 UTC temperature data of 17 October of Trivandrum rates of precipitation at different heights from surface to 600 hPa are calculated by Palmer's (*see* ref.) moisture flux formulae.

$$\text{Rate of precipitation} = \frac{1}{g}\int_{B} Q \nabla . \mathbf{V} dp$$

where, g = the acceleration due to gravity,

Q = the specific humidity,

$\nabla . \mathbf{V}$ = the horizontal divergence at particular level,

dp = the thickness of layer.

Rates of precipitation are calculated for different levels (Fig. 6) which reveal steadily increasing contribution from surface up to 850 hPa and then gradual decrease upwards.

2.6. An examination of the hyetogram of Trivandrum (Fig. 1) reveals exceptionally heavy rates of precipitation, *i.e.*, nearly 6.7 cm/hr at 1730 UTC for about 45 minutes, 10 cm/hr at 2040 UTC for about 30 minutes and 8.4 cm/hr at 0120 UTC on 18 October 1964 for about 55 minutes even though the average rate of rainfall during this continuous rainspell was about 4.5 cm/hr.

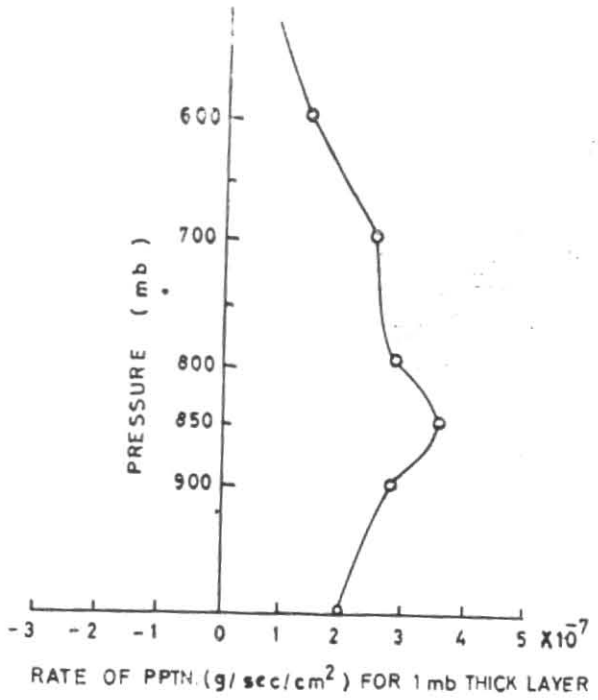


Fig. 6. Contribution to rate of precipitation from various levels

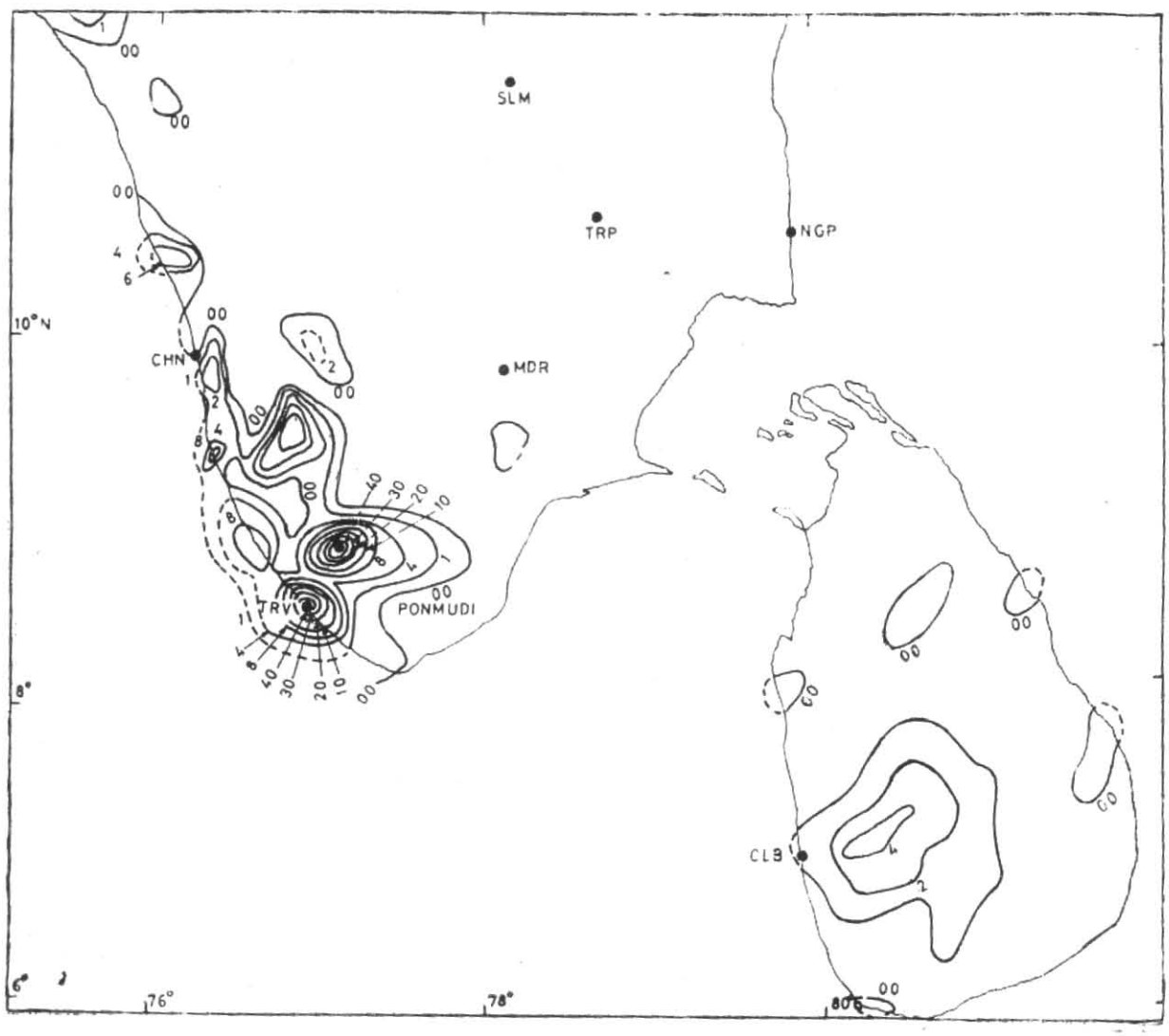


Fig. 7. Rainfall (in cm) recorded at 03 UTC of 18 October 1954

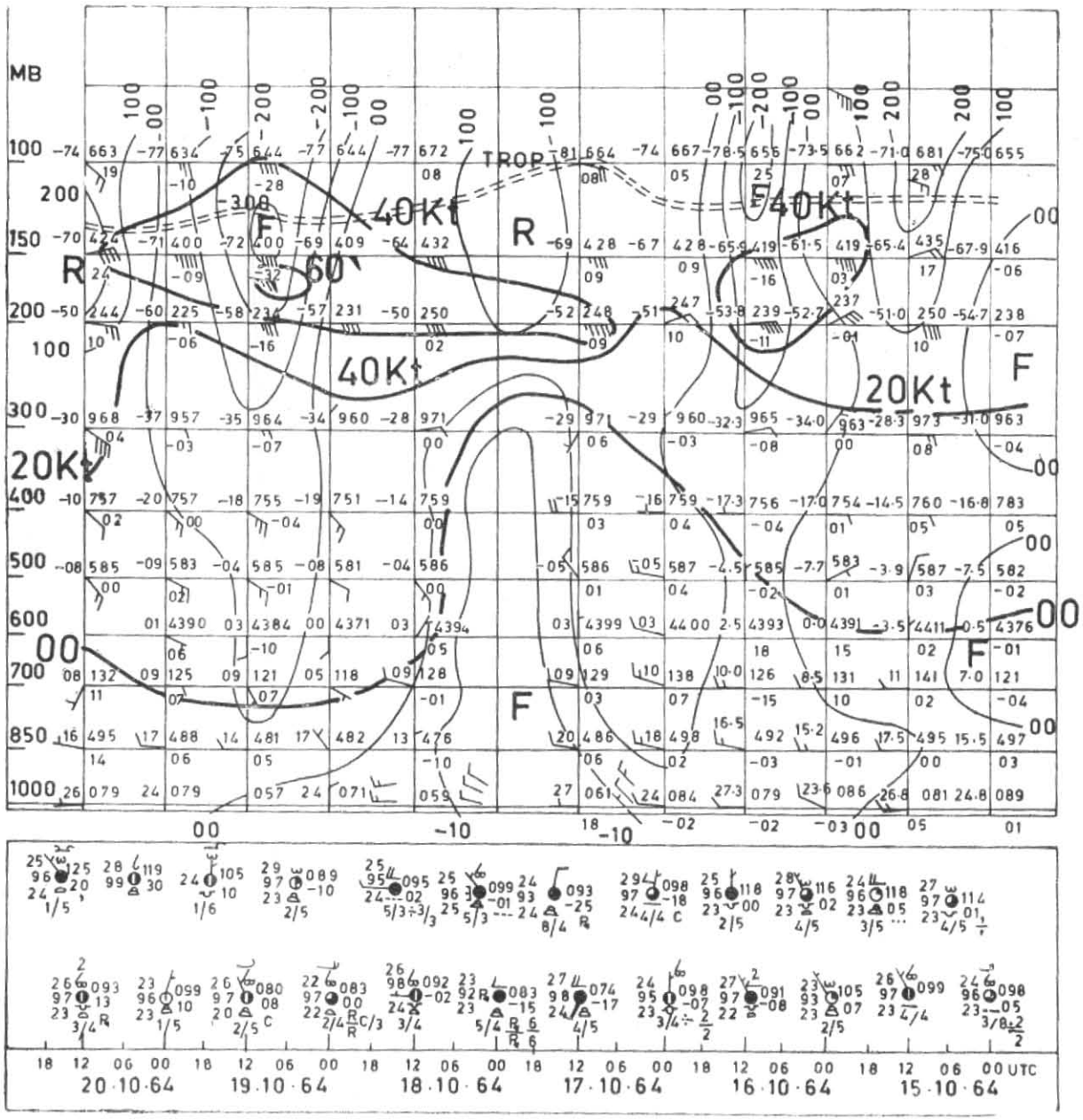


Fig. 8. Vertical time-section of Trivandrum, 15-20 October 1964

2.7. Isohyets of rainfall recorded at 03 UTC on 18 October 1964 (Fig. 7) reveal two rainfall maxima of 40.10 cm at Trivandrum and 40.64 cm at Ponmudi separated by a distance of about 10 km with a minima of 5 cm at Nedunmangad in between. It could be possible that there could be matching subsidence surrounding this intense convection in the thunderstorm cloud cluster or the orography could have caused this distribution.

The examination of climatological records of Trivandrum reveal that record 24 hours rainfall of 27.79 cm occurred on 15 May 1926 and second highest of 21.59 cm occurred on 29 October 1908. The embedded meso-scale vortices in the westerly moist current temporarily strengthen it and cause heavy falls.

Long duration of sustained thunderstorm with heavy rainfall and absence of strong surface winds or squalls also suggest dynamical reasons for continued thunderstorm activity in the form of meso-scale low level vortex.

Isohyets (chart not shown) for 19 October 1964 show a maxima of 20 cm at Ponmudi while Trivandrum received only 1/2 cm of rainfall and Nedunmangad 7 cm; 2 cm more than the previous day. Second maxima lies along the Western Ghats at Shertalla 11.36 cm. There are indications of another maxima between Madurai and Tiruchirapalli. Orography in association with the convergence observed for 00 UTC of 19 October at 3000 ft (Fig. 5b) might have been responsible for heavy rainfall at Ponmudi for the 2nd day in succession.

This low pressure area moved away northeastwards (India Met. Dep.) and the area of maximum rainfall also followed it. This finally became insignificant and merged into the seasonal low in Bay.

3. Conclusion

Occasionally small vortices with considerable vertical extent, temporarily strengthening low level westerlies cross over the Western Ghats and give concentrated heavy rainfall in association with the orography prevailing at these places. These vortices move further east to northeastward become less important and sometimes accentuate rainfall in the eastern regions as well. It appears the unusually heavy point-rainfall is more probable when unique combination of large conditional instability in environment and pulling up of moist southwesterly current under the influence of some meso-scale vortex may occasionally be achieved under favourable conditions of matching upper tropospheric divergence.

Acknowledgements

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References

Bellamy, 1949, *Bull. Am. met. Soc.*, pp. 45-59.

Daniel, C.E.J. and Subramanian, A.M., 1966, Exceptionally heavy rainfall in south Kerala on 17/18 October 1964, *Indian J. Met. Geophys.*, **17**, pp. 253-256.

India Met. Dep., *Indian Daily Weather Report* (IDWR) published by Deputy Director General of Meteorology (Weather Forecasting).

Palmer's—I.H.D. Note No. 1.