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Unusual heavy rainfall during January to March 1984 over Peninsular India

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सार — प्रायद्वीपीय भारत पर ग्रीष्म मानसून के निवर्तन की अवस्था (जो प्रायः उत्तर-पूर्वी मानसून के नाम से जाना जाता है) से सम्बद्ध वर्षण प्रायः दिसम्बर के अन्त में समाप्त हो जाता है। सामान्यतः देश के इस भाग में जनवरी से मार्च के दौरान का वर्षण महत्वपूर्ण नहीं होता। तथापि 1984 के जनवरी से मार्च के दौरान, प्रायद्वीपीय भारत के कुछ मौसम वैज्ञानिक उपखण्डों जैसे तमिलनाडु और पांडिचेरी, केरल और तटीय कर्नाटक में अपवाद स्वरूप भारी मात्रा में वर्षा हुई है। इस शोध-पत्र में उन सिनॉप्टिक परिस्थितियों का पता लगाने का प्रयत्न किया गया है जिनके फलस्वरूप यह भारी वर्षा हुई थी।

ABSTRACT. The rainfall associated with the retreating phase of the summer monsoon (popularly known as northeast monsoon), generally ends by the end of December over the Peninsular India. Normally, rainfall during January to March is insignificant over this part of the country. However, in 1984, the rainfall during January to March was in exceptionally large excess from the normal in some of the meteorological sub-divisions in Peninsular India like Tamilnadu & Pondicherry, Kerala and coastal Karnataka. In this paper, an attempt has been made to investigate the synoptic situations leading to this excess rainfall.

1. Introduction

The Peninsular India often receives widespread rain, sometimes with heavy falls during the retreating phase of the southwest monsoon (popularly known as northeast monsoon) from mid-October to the end of December. Agricultural strategies in these areas are, therefore, planned accordingly. January-February is the harvesting season for the Peninsular India and widespread rainfall or heavy rainfall during this period is considered to be harmful for the crops. In 1984, vast areas of southern States received spells of widespread rain with heavy rainfall on a few occasions resulting in huge loss of harvestable agricultural standing crops (particularly paddy crop) in Tamilnadu and Andhra Pradesh. There was widespread rain with scattered heavy (8-12 cm) to very heavy (13 cm and above) rainfall in a few spells over southern States. These spells are listed in Table 1. In this paper an analysis of the synoptic situations leading to such above normal rainfall is presented.

2. Data

To assess the rainfall distribution over the southern Peninsula during January-March 1984, the rainfall data of the State raingauge stations from Tamilnadu, Andhra Pradesh, Karnataka and Kerala were analysed. Percentage departure of rainfall from their normal for the months of January, February, March and the period January to March 1984, were computed and compared with those for the period 1901 to 1984. These are presented in Table 2.

3. Analysis of data

Comparative study of percentage departures of rainfall since 1901 to 1984 (Table 2) reveals that it was highest in Tamilnadu during February and March 1984 and second highest during January. While Kerala had the highest rainfall in February 1984, third highest in March and seventh highest in January. Coastal and south interior Karnataka had highest in March 1984 while for February month it was much on positive side. Coastal Karnataka had large excess in January 1984 also. North interior Karnataka had large excess during February & March 1984. Rayalaseema was in large excess during February & March 1984 while coastal Andhra Pradesh during January & February 1984.

3.1. *Cumulative rainfall*

The cumulative percentage departures of rainfall for January to March in 1984 for four meteorological sub-divisions in south Peninsula were as follows :

(*i*) +211% in Kerala,

(*ii*) +749% in south interior Karnataka,

(*iii*) +425% in Tamilnadu and

(*iv*) +467% in coastal Karnataka.

These were the highest figures of percentage departures of rainfall during the past 84 years. The percentage departure of rainfall for this period over Telangana was, however, highly deficient (—60%).

TABLE 1

Major rainfall spells in January-March 1984

Region	January	February	March
Tamilnadu	13-16, 18-19, 29-30	5-8, 12-17	3-9, 14-15
Kerala	15-18, 20-21	7, 13-14, 17-21	3-10
Karnataka			5-9
Andhra Pradesh		7-8, 13-17	6, 12-14

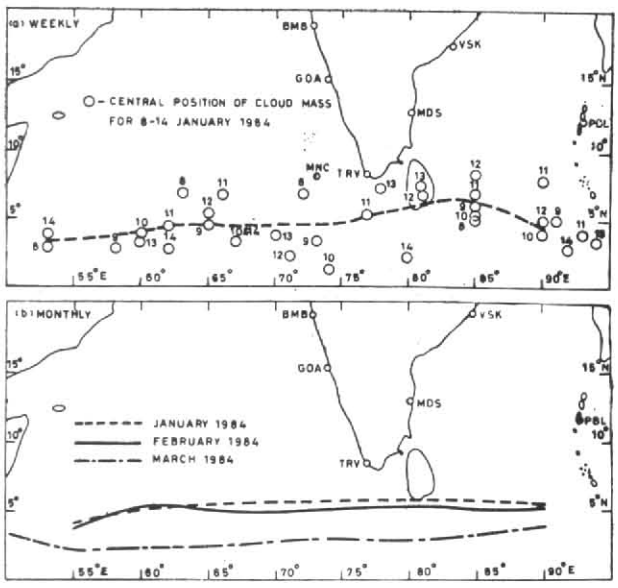

Fig. 1. Mean (a) weekly and (b) monthly positions of ITCZ

TABLE 2

Monthly rainfall in January-March 1984

Region		January			February			March		
		A (mm)	*N* (mm)	(*A*-*N*)/*N* (%)	*A* (mm)	*N* (mm)	(*A*-*N*)/*N* (%)	*A* (mm)	*N* (mm)	(*A*-*N*)/*N* (%)
1. Tamilnadu		5310	1340	296	5979	707	745	2862	646	343
	X	One								
	Y	1923		342						
2. Kerala		996	425	134	2531	445	469	2399	1037	131
	X	Six						Two		
	Y	1934		362				1946		176
3. Coastal Karnataka		128	54	136	111	41	172	873	101	762
	X	Seven			Three					
	Y	1906		653	1917		1561			
4. North Interior Karnataka		Actual rainfall was not significant			298	91	227	429	157	174
	X				Six			Five		
	Y				1928		1096	1923		542
5. South Interior Karnataka		Actual rainfall was not significant			846	221	284	8411	482	1644
	X				Four					
	Y				1928		787			
6. Coastal Andhra Pradesh		130	82	59	344	104	231	Actual rainfall was not significant		
	X	Eleven			Four					
	Y	1908		405	1936		791			
7. Telangana		Actual rainfall was not significant in all the three months								
8. Rayalaseema		Actual rainfall was not significant			85	25	243	131	21	628
	X				Five			Two		
	Y				1917		771	1944		841

A — Actual rainfall (mm), *N* — Normal rainfall (mm), (*A* — *N*)/*N* % — Actual rainfall as percentage of normal,
X — Number of years during the period 1901-1984 where the actual rainfall for the month was in excess of that for 1984.
Y — Year of highest rainfall for the month with the percentage (*A*—*N*)/*N* in brackets.

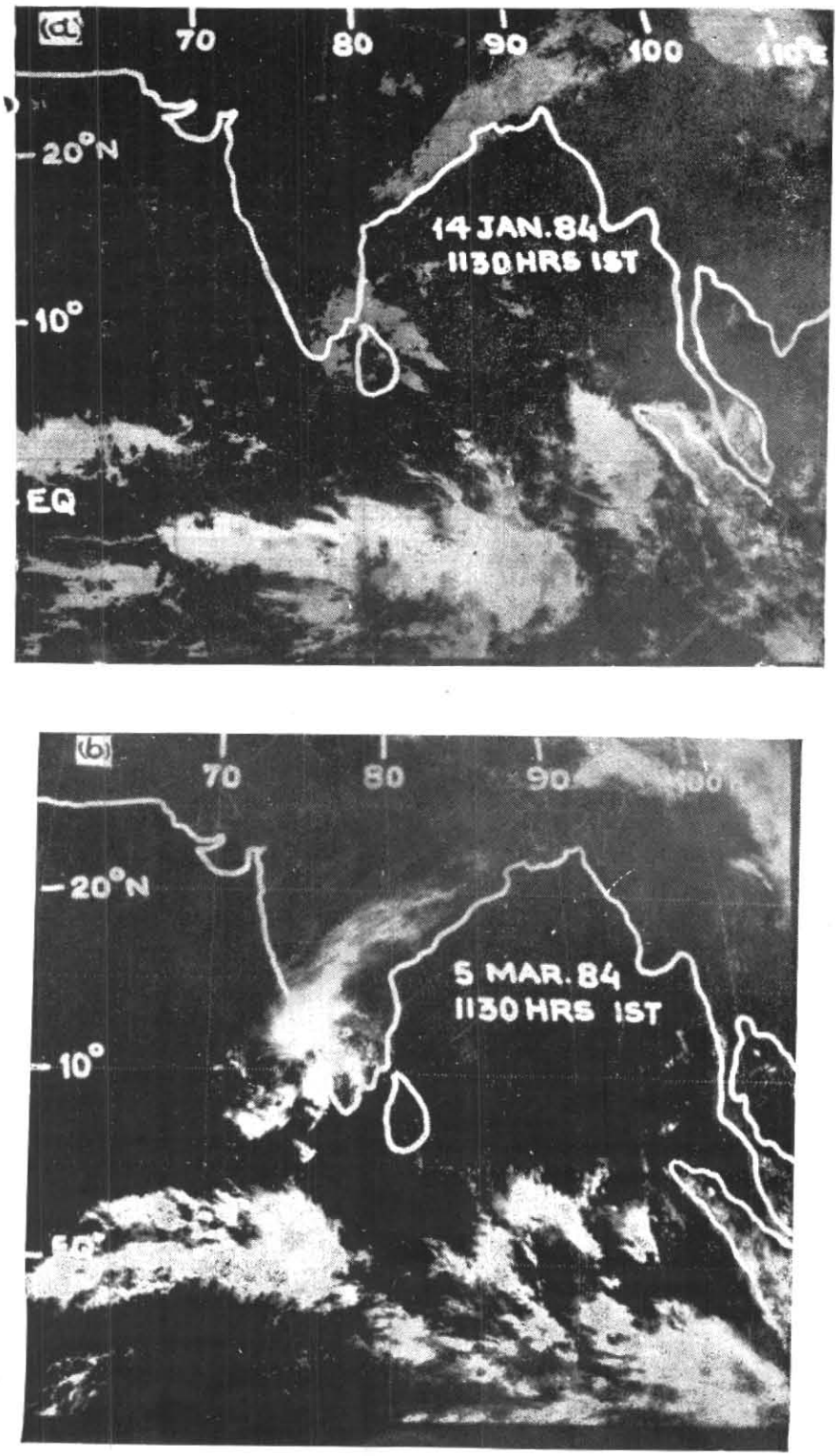

Fig. 2. INSAT-1B cloud pictures of 14 January and 5 March 1984

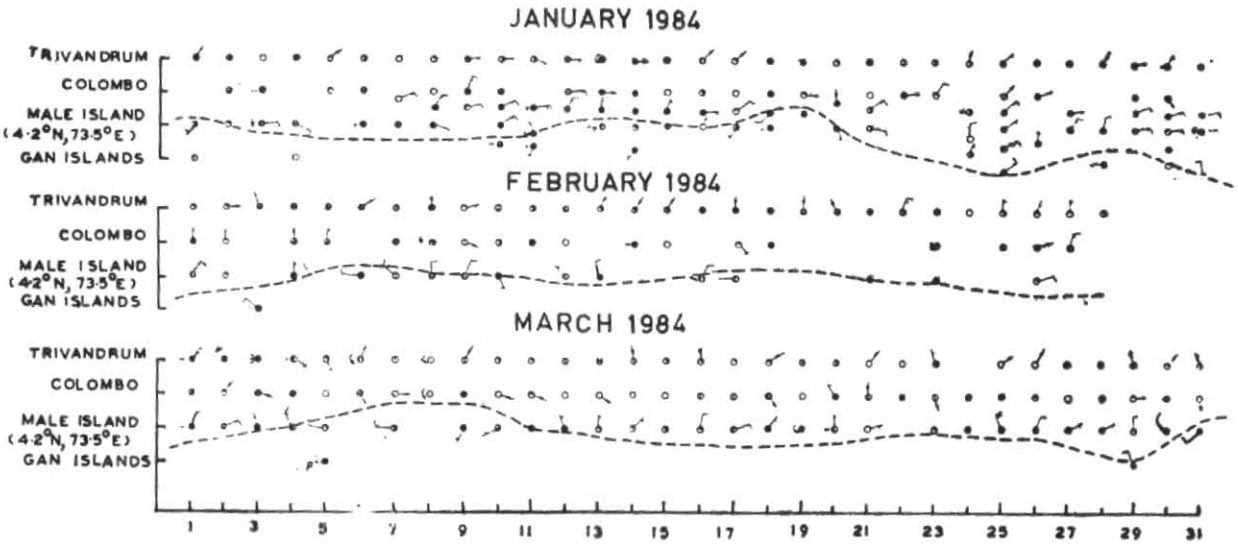

Fig. 3. Day to-day fluctuation of ITCZ for January-March 1984

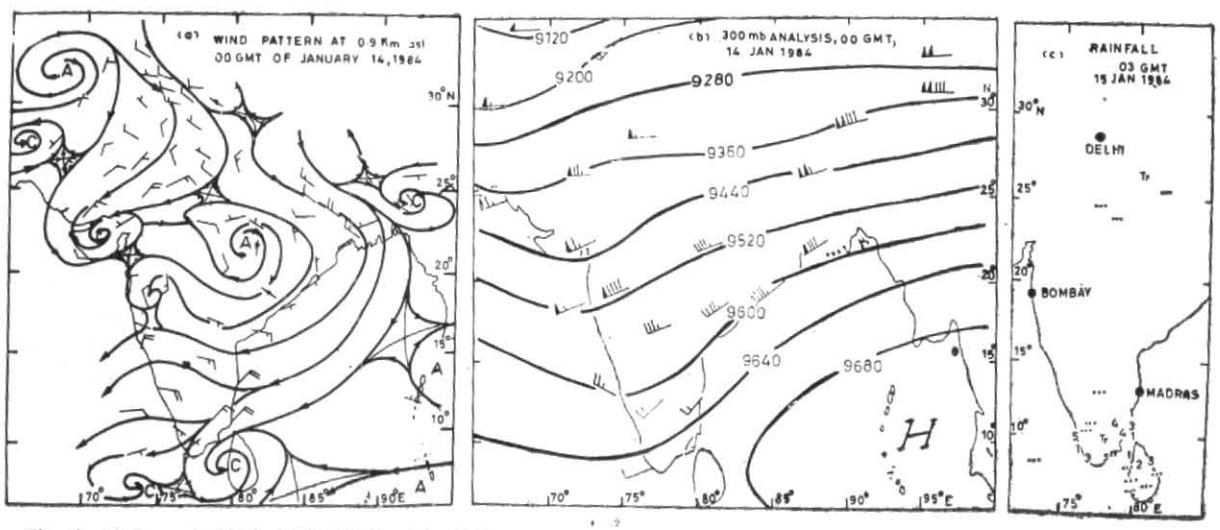

Fig. 4. 14 January 1984 at 00 GMT : (a) wind pattern at 0.9 km a.s.l., (b) 300 mb analysis and (c) rainfall (cm) at 03 GMT of 15 Jan 1984

4. Synoptic situations

In the following paragraphs the synoptic situations leading to such exceptional rainfall over the Peninsular India in 1984 are presented.

4.1. *Position of ITCZ*

The Inter Tropical Convergence Zone (ITCZ) is usually associated with good cloudiness and rainfall. Low pressure systems or cyclonic circulations forming over the ITCZ accentuate the cloudiness and cause good rainfall in the zone. In January-February-March, the ITCZ on the mean lay to the south of the Indian Peninsula close to the equator. *The location of the ITCZ undergoes* fluctuations in association with low pressure systems moving from east to west at low latitudes in this season. To investigate whether the spells of heavy rainfall in January-February-March 1984, were in association with temporary northward displacements of the ITCZ, the INSAT-1B satellite cloud pictures were examined for delineating the location of the ITCZ. All the satellite pictures with significant cloudiness in the ITCZ area were selected. The area of cloudiness (northern and southern limits) were transposed on a transparency. The weekly mean position of the ITCZ obtained in this manner for the week, 8-14 January 1984, is shown in Fig. 1(a). The monthly mean positions of ITCZ for January, February and March 1984, are shown in Fig. 1(b). The figure indicates that the ITCZ in 1984 was roughly along 6° N in January and February and 3° N in March. Day to day positions, however, fluctuated between 5° N and 12° N in January and February and between equator and 10° N in March 1984.

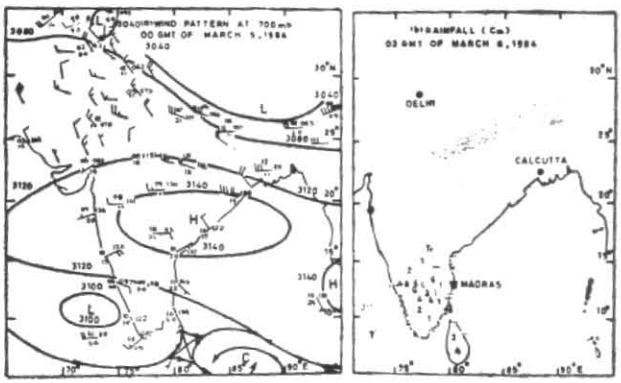

Fig. 5. (a) Wind pattern at 700 mb, 00 GMT of 5 March and (b) rainfall (cm) at 03 GMT of 6 March 1984

For analysing the day to day position of ITCZ in these months, surface data for Gan Island, Male Island, Colombo and Trivandrum were plotted each day and the line, delineating the easterlies and westerlies were marked. These lines are shown in Fig. 3 along with the plotted data. This also gives an idea of day to day position of the ITCZ over south Peninsula and its adjoining areas.

Since the positions of the ITCZ in this period were in a more northerly latitude than the normal position, the weather system also formed and moved in a more northerly position affecting the Peninsular India and giving above normal rainfall.

4.2. *Formation of cyclonic circulation in the ITCZ*

During this period of active rain spells listed in Table 1, four cyclonic circulations formed in the ITCZ but slightly to its north and moved across south Peninsula in January, two in February and two in March 1984. The rains were significant and heavy when they were juxtaposed with a trough in the westerlies to their west. For illustration, wind patterns of 00 GMT of 14 January 1984 at 900 m a.s.l. and 300 mb, and rainfall of 15 January are shown in Figs. 4 (a-c). The satellite picture of 1130 IST of 14 January 1984 is shown in Fig. 2(a). There was a trough in the westerlies at 300 mb (0530 IST) on 14 January running roughly parallel to the west coast of the country.

These cyclonic circulations forming at comparatively higher latitudes were responsible for the above normal rainfall in Peninsular India in January to March 1984.

4.3. *Semi-permanent cyclonic circulations off south Tamilnadu-Sri Lanka and off Kerala coast*

A cyclonic circulation was observed almost every day between 5 & 10 February 1984 in the lower levels (extending up to 850 mb) off south Tamilnadu and Sri Lanka coast. Tamilnadu received fairly widespread rain with isolated heavy falls over coastal Tamilnadu during this period.

A cyclonic circulation, after moving westward through extreme south Peninsula, emerged off Kerala coast on 3 March 1984. It remained almost stationary over the area for about 3 days and then moved slightly northward up to Karnataka coast. Circulation became very well marked on 5th when it extended up to 500 mb. There was an upper air trough roughly along 71° E between 30°N and 10°N. The 700 mb chart of 5th and 24 hours rainfall of 6 March 1984 are presented in Fig. 5(a & b). The INSAT-1B picture of 1130 IST of 5 March is shown in Fig. 2(b). This circulation remained almost quasi-stationary off Kerala-Karnataka coast up to 10 March 1984 causing fairly widespread to widespread rainfall over Kerala, Karnataka and Tamilnadu on most of these days.

4.4. *Development of very large number of tropical cyclones over the equatorial south Indian Ocean*

The effect of strong cyclonic vortices in the south Indian Ocean close to the equator has been studied by Kuettner (1967) and Mukherjee & Padmanathan (1977). Increase in the strength of the equatorial westerlies in northern and southern hemispheres on such situations and consequent increase in shear vorticity over these areas is postulated. In January to March 1984, there were large number of tropical cyclones forming in the equatorial areas of southern hemisphere within the Indian longitudes. There were 18 depressions and 7 tropical cyclones during this period over the equatorial south Indian Ocean. They might have contributed in the formation of comparatively larger number of cyclonic vortices during January to March 1984.

5. Conclusion

The study reveals that the unusually heavy rainfall over the southern parts of Peninsular India in January February-March 1984 which caused considerable damage to crops was in association with :

(*i*) the northward shift of the ITCZ from its normal location close to the equator ;

(*ii*) the formation of a large number of active cyclonic vortices in the ITCZ region and their westward movement across the south Peninsula ;

(*iii*) the formation of quasi-stationary cyclonic circulations off the coasts of south Tamilnadu, Sri Lanka and Kerala-Karnataka and

(*iv*) the possible influence of a large number of cyclonic storms and depressions that formed in the equatorial south Indian Ocean during these months.

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