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The extra-ordinary path of the Bay of Bengal Storm of 7-15 December 1965 in relation to the Tiros 10 Satellite observations and the Upper Tropospheric Wind-field

D. R. SWAMINATHAN

Main Meteorological Office, Madras

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ABSTRACT. The extra-ordinary path of the Bay of Bengal storm of 7–15 December 1965, the upper tropospheric wind-field which steered the movement and the Tiros 10 Satellite observations of the storm are discussed in this paper. Some rare features of the storm are also presented.

1. Introduction

A cyclonic storm which formed over southeast Bay of Bengal on 7 December 1965 pursued an extra-ordinary track, as it moved across the Bay and crossed East Pakistan coast near Chittagong on 15 December. According to press reports tidal waves and 100 mile/hr winds associated with the storm hit many off-shore islands, destroyed communication lines and caused heavy casualties in the devastated areas along the coast and inland upto the Burma border.

Simultaneously another cyclonic storm also formed over Laccadives area on 7 December, recurved northeastwards, later moved northwards along the west coast and weakened near Harnai by 12 December. It also caused heavy damage to property and some loss of life in the coastal areas of Kerala where disruption of telegraphic and telephonic communications were also reported.

In this context, the upper tropospheric wind-field that steered the movement of the Bay storm, the Tiros 10 Satellite observations which gave clue to the extra-ordinary path and some rare features of the storm are discussed here.

2. The track of the Bay of Bengal Storm of 7–15 December 1965

The track of the Bay storm, from its origin as a depression over south Andaman Sea on 6 December, to its crossing the coast near Chittagong as a severe cyclonic storm on 15 December, is shown in Fig. 1. The southwesterly displacement with such a sharp turning and abrupt change in direction is abnormal while the whole track is one of the rarest on record. This very rare storm track is made up of three distinct paths, namely, (1) initial recurvature from 7 to 10 December, (2) unusual displacement from 10th to 12th and (3) second recurvature from 12 to 15 December.

Satellite observations from 6 to 14 December, giving details of storm centre and cloud cover, which were the main source to confirm, particularly the extra-ordinary movement from 10 to 12 December, are given in Table 1.

The track of the other cyclonic storm which was in progress in the Arabian Sea from 6-12 December is also shown in Fig. 1. Simultaneous progress of two storms is also a rare occurrence.

3. The Study

(*a*) *Initial recurvature from 7–10 December 1965* — Riehl (1954) has stated that 'United States Weather Bureau Forecasters have been aware for many years that middle latitude influences determine recurvature'. In the present study it was found that a mid-latitude trough extending equatorwards upto about Lat. 18°N (Fig. 2) was moving eastwards during the period 7-10 December. Therefore it may be said that the storm, under the influence of the westerly trough, drifted polewards from Lat. 8·0°N on 7 December to Lat. 14·5°N on 10 December, gradually recurving northeastwards, as was the general tendency of the storms that originate in southeast Bay in December as mentioned in *Tracks of Storms and Depression in the Bay of Bengal and the Arabian Sea* (India met. Dep. 1964).

During the above period, the Arabian Sea storm also recurved initially northeastwards and later moved northwards along the west coast. An interesting observation of the storm pair was that the mid-point of the line joining the centres of the two storms was found to shift northwards (Fig. 1), which according to Riehl (*loc. cit*) was an indication that 'outside systems influenced the movement of the storm pair'.

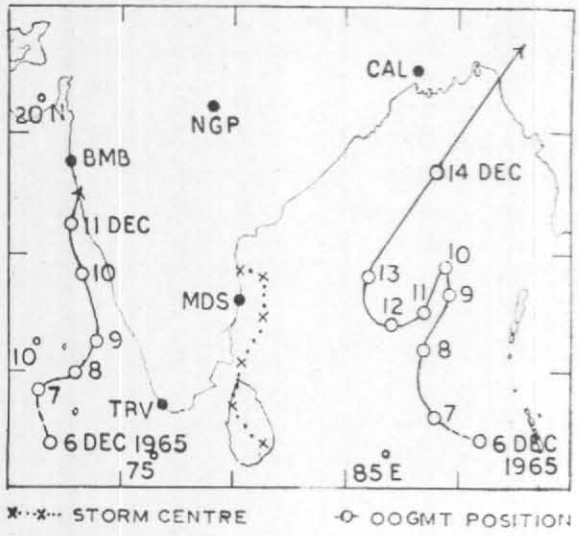

Fig. 1. Tracks of strorm pair
Bay of Bengal storm of 7-15-Dec 1965
Arabian Sea storm of 7-12 Dec 1965

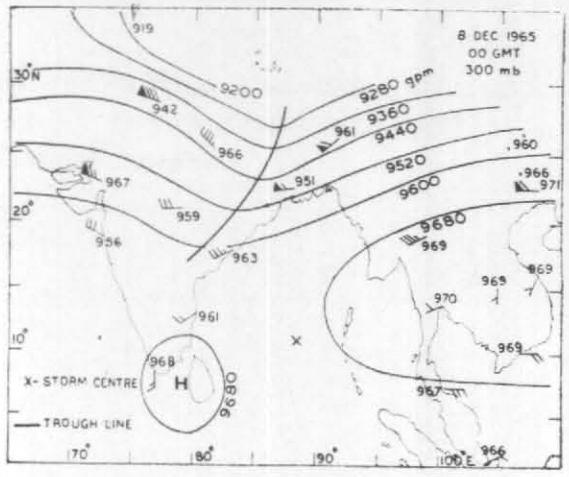

Fig. 2. 300-mb contour chart, 00 GMT of 8 Dec 1965

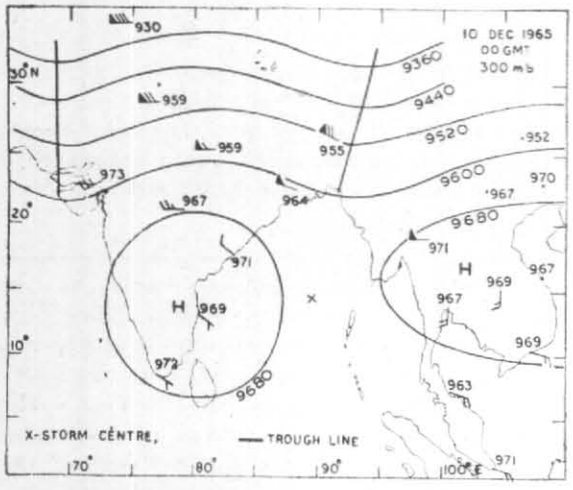

Fig. 3. 300-mb contour chart, 00 GMT of 10 Dec 1965

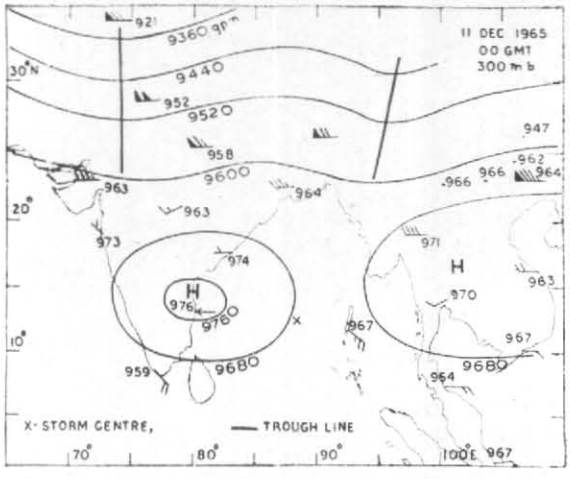

Fig. 4. 300-mb contour chart, 00 GMT of 11 Dec 1965

(*b*) *Unusual displacement of the Bay Storm from 10–12 December 1965* — From 10 to 12 December the storm traced an extra-ordinary path with sharp turning and abrupt change in its course on 10 December. Satellite observations during 10 to 12 December gave clue and confirmed this unusual and extra-ordinary movement which, probably, could not have been inferred otherwise.

For the contour analysis presented in the following paragraphs, the wind and radiosonde data available were unfortunately meagre especially in the crucial region, the Bay of Bengal. Hence, it is realised that there could be more than one method of drawing the contours over that area. The author's conclusions can, therefore, be considered only as broad indication of what one should expect from a post-mortem analysis of the meagre data. Further, on account of the errors in the high-level radiosonde data, the labelling of the contours has been, to some extent, arbitrary. However, as the author's conclusions do not depend upon the steepness of the contour-gradients but only on *the direction of flow* for which the author has depended on the direction of the reported winds, the precise values given to the isopleths of the contours do not affect his conclusions.

According to Riehl 'Changes in the steering high are the most important factors in producing a sharp turning of the cyclone path and such changes are usually initiated by the arrival of a mid-latitude trough from the west'. In the

TABLE 1

Tiros-10 observations over Bay of Bengal from 6 to 14 December 1965

Date Dec 1965	Time (GMT)	Central region Lat. (°N)	Central region Long. (°E)	Particulars
6	0528	7	91	*Disturbed area* with an apparent centre of circulation. Overcast cloud area from 6° to 13°N and from 86° to 92°E
7	0458	8	89	*Vortex* with a central overcast area 2° in diameter. Cirrus outflow and spiral banding
8 & 9		No picture		
10	0510	14·5	89·5	*Weak tropical cyclone*: Spiral banding all quadrants
11	0439	12·5	89·0	*Tropical cyclone*: Banding north and east of centre
12	0550	12	87	*Tropical cyclone with well-defined eye*: Spiral banding all quadrants
13	0520	14	86	*Vortex with eye visible*: Central overcast area 5 degrees in diameter with cirrus outflow and spiral banding
14	0452	18·5	89	*Vortex with eye visible*: Long wide band extends northeast from storm–broken to overcast *Cb* bands around storm centre extending to eastern portions of West Bengal, Assam and Burma

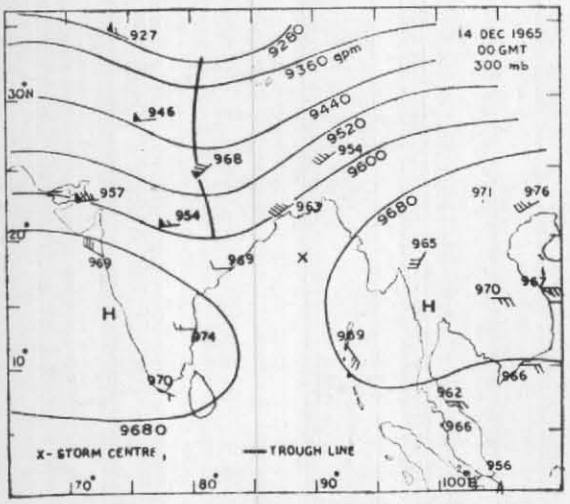

Fig. 5. 300-mb contour chart, 00 GMT of 14 Dec 1965

present study also it was found that a second mid-latitude trough was moving eastwards to the rear of the first which was also moving eastwards and whose axis lay to the east of the longitude of Calcutta by 00 GMT of 10 December. And the wind field at steering level also changed remarkably from a southerly flow on 8 December to a northerly flow on 10 December (Figs. 2 and 3).

Therefore, it may be said that the second trough caused the subtropical high aloft to move eastwards and southwards to a latitude lower than that of the storm. Hence by 00 GMT of 10 December, the storm centre was under the influence of northerlies of the eastern edge of the subtropical high pressure cell (Fig. 3) and so it suddenly and abruptly changed its course and moved southsouthwestwards from 10 to 11 December.

On 11 December also the high pressure cell persisted (Fig. 4) but by now the storm centre was under the influence of the southern edge and so it gradually turned southwestwards from 11 to 12 December.

On the morning of 12 December, the anticyclonic cell over Indo-China Peninsula began to get accentuated and extend westwards. The high over the south of the Indian Peninsula also correspondingly shifted westwards. The steering windfield, therefore, correspondingly changed. The further southwestward movement of the storm was thus arrested on 12th and the path of the storm also subsequently changed.

(c) *Second Recurvature from 12 to 15 December 1965* — During the period 13–15 December, the storm came progressively under the influence of the high level southwesterlies in the confluent wind-field between the forward sector of the second westerly trough and the high over Burma and Indo-China Peninsula (Fig. 5). Hence it recurved a second time and moving rapidly northeastwards crossed East Pakistan coast near Chittagong, on 15 December. Thereafter it weakened over land and became unimportant.

4. Some rare features of the storm

1. The simultaneous progress of two storms, one in the Bay of Bengal and the other in the Arabian Sea was a very rare occurrence, since only 5 such occurrences were observed in 70 years

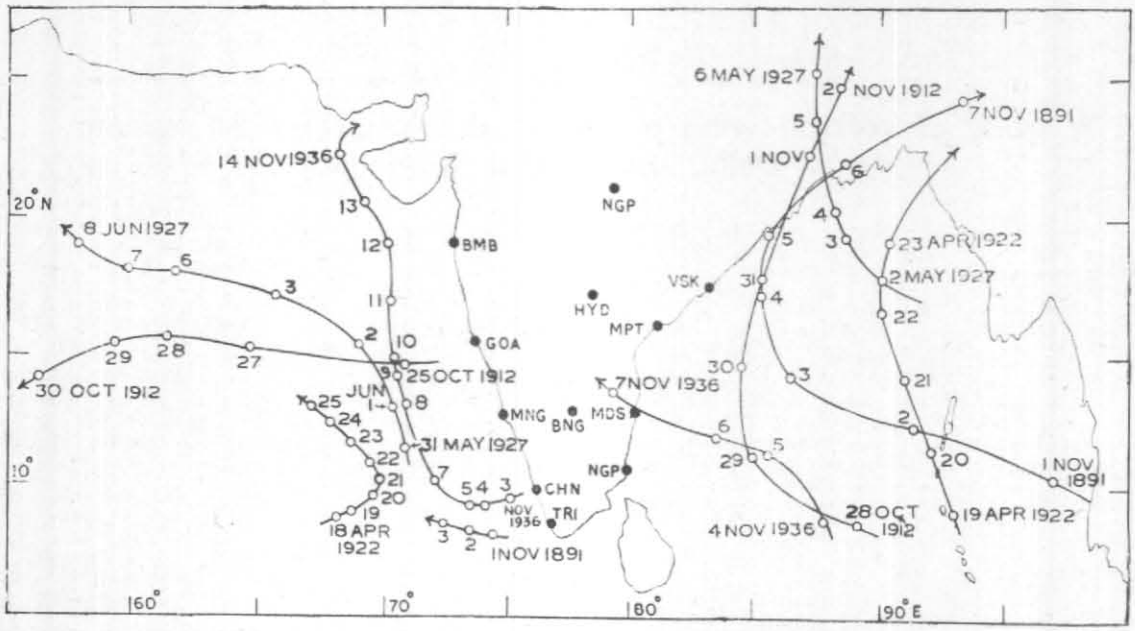

Fig. 6. Tracks of storm pairs in Indian Seas during 1891-1960

TABLE 2

Details of storm pairs in the Bay of Bengal and the Arabian Sea (1891—1960)

Year	Month	At origin			Longitudinal distance between centres
		Date	Lat. (°N)	Long. (°E)	
1891	Nov	1	8·0	74·5	
		1	9·5	98·5	24·0
1912	Oct	25	15·0	72·5	
		28	8·5	89·0	16·5
1922	Apr	18	9·0	68·5	
		19	9·5	93·0	24·5
1927	May	31	11·5	71·0	
		31	17·5	91·5	20·5
1936	Nov	3	9·5	75·0	
		4	9·0	88·0	13·0
	Average				19·7

from 1891 to 1960 (Fig. 6), details of which are given in Table 2.

Another interesting observation about the storm pair was the longitudinal distance of 19 degrees between their centres at origin which agreed with the average of 19·7 degrees for the five pairs. The average wave length of an easterly wave according to Riehl was about 20 degrees thus suggesting that the storm pair might be forming at the two corresponding points of an easterly wave.

2. Another rare feature of the storm was the long life-span of 9 days. During the 70-year period mentioned earlier, 77 per cent of storms lasted only for 1 to 4 days while 17 per cent lasted for 5 to 6 days and only 7 per cent (3 storms) lasted for 7 days giving an average of about $3\frac{1}{2}$ days for December storms in Bay of Bengal. But according to Riehl, the average life-span for tropical cyclones was 6 days.

3. Yet another unusual feature was that this storm was one of the few that crossed East Pakistan-Burma coast during December since only 13 per cent had done so in the 70-year period mentioned earlier while 61 per cent, weakened in the sea itself and 15 and 11 per cent crossed Madras and Ceylon coasts respectively.

4. According to Riehl, 'abnormal tracks occur far too often and all kinds of aberrations appear; humps, southwestward and southeastward displacement and even loops'. In the Indian Seas also they were frequent since during the 70-year period mentioned earlier, there were 12 tracks with southwestward displacement and a few abnormal or multicurvature tracks also.

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