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The excessive rainfall over Thailand in January 1975

PATIPAT PATVIVATSIRI

Meteorological Department, Bangkok, Thailand

ABSTRACT. The present study discusses the three-dimensional circulation in the region between 75°-150°E, 10°S-50°N, as well as the associated rainfall in Southern Thailand during the period from 3 to 8 January 1975. The weather system of period studied produced one of the wettest northeast monsoons ever recorded in this country, and caused widespread floods over the Southern Thailand. Synoptic investigation is described. The rainfall data and strong northeast monsoon winds are tabulated. Synoptic charts, satellite coverage and meteorological radar observations are also presented.

The study found that the exceptionally heavy rain recorded in Southern Thailand during the northeast monsoon season of 1975 was caused mainly by the prolonged existence of active low cells in an area south of Southern Thailand and Malaysia bounded by latitudes 0°—9°N and by the trough at 700 mb near 85°E and 95°E over Burma and northern Bay of Bengal. Also a depression in the Andaman Sea appeared to have an important effect on intensity of rainfall. Synoptic features which show the circulation in the layer of the atmosphere below 500 mb appear to control the weather phenomena, and seem to have the most direct effect upon distribution of rainfall.

1. Introduction

Millions of lives in Southeast Asia are totally dependent on the monsoon systems. On the one hand, failure of the monsoon to occur at the appropriate time will be catastrophic in the developing nations in the area as there will be no water to sustain agriculture most possibly leading to starvation, famine and others. On the other hand, excess rainfall due to the monsoon system would lead to disaster as well by way of damage to crops, rendering people homeless and others.

Generally the entire southwest monsoon system in many parts of tropical Asia affects the lives and economies of more of the world's population than does any other weather regime on earth. Recently, however, the vagaries of the northeast monsoon weather aroused unusual public interest in Thailand. This phenomenon of nature was one of the most severe weather systems during the past two decades observed in Thailand in early 1975. It caused widespread floods over the Southern Thailand. The reports of damage to life and property due to this weather system are sufficient to indicate its great significance. The Department of Local Administration reported the following : loss of lives, 254; families affected, 130,000. Damage to public property was estimated at 705,000,000 baht.

2. General climatic condition

The climate of Thailand is tropical, although cold air surges from the China mainland occasionally flow into the country during the winter. Temperature remains above freezing except infrequently on high peaks where frost may occur. Rainfall amounts vary greatly from place to place and from season to season. Much of rainfall occurs as heavy showers or thundershowers. Typhoons occasionally approach the country from the east, but before reaching Thailand they cross the mountain ranges in the neighbouring countries, *i.e.*, Cambodia and Laos, where much of their energy is dissipated.

The climatic seasons are based on two major wind systems, the northeast and southwest monsoons, each with its own weather characteristics. The northeast monsoon season is the dry winter season, extending from November to mid-February, except for the Peninsula (Southern Thailand). The southwest monsoon season, mid-May through September is the rainy season. For most of the country during this period are characterized by successive increases in amount of rainfall, September usually being the wettest month. Between the major monsoons is the summer season, mid-February to mid-May, characterized by easterly and southeast winds and April is the hottest month of the year. The second transitional season is usually in the month of October. During this season dry northeast winds replace those from the southwest and rainfall decreases except over the Peninsula.

The climate of Southern Thailand Peninsula differs from that of the remainder of Thailand. During the northeast monsoon, the temperatures are higher and the precipitation is heavier and more frequent than in the other regions. The greatest contrast is in November, December and January, when Southern Thailand is humid and rainy while other sections are comparatively cool and almost rainless. Maximum rainfall in 24 hours, date and number of rainy days for Southern Thailand are given in Table 1. During the period 1970-74, Ranong (Fig. 1) recorded the highest daily rainfall in Southern Thailand—460·9 mm on 22 June 1970.

3. The heavy rainfall

In 1975, the northeast monsoon rainfall early in January over Southern Thailand was much above average. There were many heavy (more than 50 mm) daily falls, particularly over the Southern Thailand East Coast where it was the heaviest and most widespread in at least 30 years. As a result, Southern Thailand was flooded badly in various places with much loss of life and damage to property.

The present study discusses the three-dimensional circulation in the region 75°-150°E, 10°S-50°N and associated rainfall in Southern Thailand during the period from 3 to 8 January 1975. The main agents of precipitation over Thailand are poorly known. However, monsoonal winds and cyclonic disturbances are likely to have important roles in the formation and release of precipitation.

The northeast monsoon season in Thailand results from the cold Siberian high pressure system. The anticyclonic circulation flows southward bringing in cool air with fairly persistent northeasterly winds. This air-stream begins a gradual development in October and extends to Thailand in occasional surges. During winter, November is the month of northeast monsoon strengthening. Precipitation increases in portions of the east coast of Southern Thailand which are perpendicularly oriented to the northeast air stream. Until December, dominance of northeast monsoon is clear, causing heavy precipitation along the east coast. Then substantial decreases along the east coast in January, and increase elsewhere tend to equalize rainfall throughout the country (Sternstein 1962).

Although this country is between two areas of typhoon activity, the Bay of Bengal and the South China Sea, storms of typhoon intensity rarely enter the country. According to the records, the movement of the storm tracks towards the south in the advanced typhoon season (October through December) passing through Peninsular Thailand is extremely susceptible to tropical cyclones. The tropical depressions and occasional tropical storms which do cross the Peninsula bring with them great amounts of rainfall and destruction of property. Tropical cyclones infrequently enter Thailand from the west. These generally are storms which have recurved after striking the Burma Coast (1st Weather Wing Special Study 105-10, 1965). The available records indicate that storms from the west rarely occur more than once every six to eight years and always arrive either during the period of April through June or October through December (Environmental Science Services Administration, 1969).

On rare occasions, the intensified northeast monsoon winds during January flow southward across Thailand toward the active equatorial low-pressure belt. Coupled with the cyclonic disturbances from the west, these produce heavy rainfall to the east coast of Southern Thailand.

4. Synoptic investigation

The synoptic conditions and associated rainfall over Southern Thailand were studied using analysed surface maps and upper level charts at 2,000 ft, 5,000 ft (850 mb), 10,000 ft (700 mb) 15,000 ft (600 mb), 18,000 ft (500 mb), 20,000 ft, 24,000 ft (400 mb) and tropopause level.

Beginning the month of January 1975, a large cold high pressure cell had dominated over Mongolia and extended its wedge to the Southern China. A low cell appeared over west of Borneo on 3 January. By 4 January, this high pressure cell had intensified, its centre displaced to China and extended the wedge to the Upper Thailand. In the meantime, the circulation of this low intensified and moved westwards slowly, centering at about 0°, 107°E (Fig. 2). On 5 January, the high pressure over China moved eastwards and its

TABLE 1

Maximum rainfall in 24 hours during the period 1970-74 in Southern Thailand

Station	Elevation above m.s.l. (m)	Maximum rainfall in 24 hours Amount (mm)	Date*	Average number of rainy days per year (over 0·1 mm)
Chumphon	2·9	264·1	29 Nov 1970	171
Ko Samui	6·0	283·3	4 Dec 1972	169
Surat Thani	10·0	147·4	28 Oct 1970	172
Nakhon Si Thamarat	7·0	241·5	30 Nov 1971	184
Songkhla	9·0	247·7	25 Nov 1971	155
Hat Yai	27·4	207·0	8 Dec 1973	162
Pattani	5·2	226·3	18 Nov 1974	153
Ya La	18·5	191·8	15 Dec 1972	99
Narathiwat	3·6	238·4	2 Dec 1973	180
Ranong**	6·2	460·9	22 Jun 1970	205
Phuket Airport**	4·8	197·6	5 Oct 1971	183
Phuket**	1·8	135·3	31 Oct 1974	173
Trang**	14·3	157·6	22 Aug 1973	171

*The 24-hour rain from 7 a.m. of that day to 7 a.m. of the following day

**Denotes Southern Thailand West Coast

TABLE 2

24-hour rainfall (mm) at selected stations in Southern Thailand

(The date heading indicates the 24-hour rain from 7 a.m. of that day to 7 a.m. of the following day)

Stations	Lnt.	Long.	Date (during the year 1975) Jan 3	Jan 4	Jan 5	Jan 6	Jan 7	Jan 8	Total
Chumphon	10°27′	99°15′	T	T	10·7	42·4	22·9	423·4	499·4
Ko Samui	09°58′	98°38′	23·3	35·0	247·9	337·1	387·4	2·4	1033·1
Surat Thani	09°08′	99°18′	37·9	82·4	137·4	28·6	7·6	11·2	305·1
Nakhon Si Thamarat	08°25′	99°58′	25·6	253·4	433·3	89·2	69·7	54·2	925·4
Songkhla	07°11′	100°37′	16·0	82·2	38·0	0·8	6·6	23·0	166·6
Hat Yai	06°56′	100°25′	22·8	247·1	8·9	T	5·2	19·5	303·5
Pattani	06°47′	101°10′	53·8	191·0	99·4	—	T	4·3	348·5
Ya La	06°33′	101°50′	133·9	146·7	—	—	—	13·1	273·7
Narathiwat	06°26′	101°51′	16·1	98·7	142·8	1·0	8·4	2·3	269·3
Ranong*	09°58′	98°38′	T	0·5	9·4	15·1	—	10·1	35·1
Phuket Airport*	08°08′	98°18′	—	39·3	0·5	T	T	38·7	78·5
Phuket*	07°58′	98°24′	—	32·7	0·2	—	T	9.0	41·9
Trang*	07°30′	99°40′	6·4	368·7	28·5	—	—	20·8	424·4

*Stations at Southern Thailand West Coast wedge still covered the Upper Thailand and neighbouring areas. A low cell weakened and moved to the east of Singapore (Fig. 3). After six hours it had disappeared. As soon as this low intensified on 4th, a second low appeared west of Malaysia, centering at about 5°N, 101°E. This new low also moved westwards slowly on the following day. On 6 January, another low cell appeared at about 9°N, 101°E in the sea, very near the east coast of Southern Thailand between Chumphon and Nakhon Si Thamarat (Fig. 4). This third low moved northwestwards on land into the vicinity of Chumphon and disappeared on the next day. The second low on 6th moved westnorthwestwards into Andaman Sea (Fig. 4) and intensified into a depression on 7 January, with its centre at about 11°N, 95·5°E. On this day the high pressure cell had moved into the Pacific, causing its wedge which covered over Upper Thailand and neighbouring areas to gradually weaken (Fig. 5). Later the depression moved northnorthwestwards until 9 January, when satellite and conventional observations indicated that the depression had moved into the Bay of Bengal far away from the country.

As soon as the first low cell formed over west of Borneo and intensified, the vertical extent of this cyclonic circulation extended upto 400 mb, with its centre shifted northwestwards at this higher level (Fig. 6). At 200 mb, a ridge of anticyclone from Pacific appeared to cover area of this low cell (Fig. 7). On the next day, a sharp 700 mb north-south trough passed through northeast of India near 90°E (Fig. 8) as the polar westerlies at 200 mb intensified and moved equatorwards (Fig. 9). On this day the first low cell which had weakened just extended upto 700 mb. The second low cell which occurred on the day and intensified under the influence of the first low cell also extended upto this level (Fig. 8). At 200 mb, a closed anticyclonic circulation appeared to cover area of these low cells (Fig. 9). During the next two days, on 6 January, the third low cell which was over the sea near the east coast of Southern Thailand at about 9°N, 101°E had its cyclonic circulation extending also upto about 700 mb. At 200 mb, a closed anticyclonic circulation also appeared over this area (figures not shown). By 7 January, a sharp 700 mb trough had appeared to increase in amplitude and moved eastwards to near 95°E. In the mean time a depression moved due northnorthwestwards from the Andaman

TABLE 3

Comparison of a 20-year (period 1951-1970) mean monthly January rainfall and total rainfall at selected stations during the period 3-8 January 1975

Stations	20-year mean monthly Jan. rainfall (mm)	Total rainfall during the period 3-8 Jan. 1975
Chumphon	118·5	499·4
Surat Thani	72·3	305·1
Nakhon Si Thamarat	203·6	925·4
Songkhla	141·3	166·6
Narathiwat	260·5	269·3
Ranong	31·8	35·1
Phuket Airport	54·1	78·5
Phuket	43·5	41·9
Trang	35·8	424·4

Sea (Fig. 10). At 200 mb, an anticyclonic circulation was shown over the area of this cyclonic disturbance at low level (Fig. 11). The summary of the development of these cyclonic disturbances is shown in (Fig. 12).

Associated with these developments, widespread rain fell in most parts of Southern Thailand except in the extreme west. A northward extension of the area affected by heavy rain could be seen from Table 2. In particular, rain fell heavily over Southern Thailand East Coast and rainfall figures of those areas in the period studied are very much in excess compared to the normal values of most stations (*see* Table 3).

This widespread rain, which caused serious flooding and loss of life in Southern Thailand, produced one of the wettest northeast monsoon weeks ever recorded in Thailand. A rainfall record of 433·3 mm on January 5th was made during the onset of this weather system. This is considered to be the highest 24-hour rainfall for Nakhon Si Thamarat. This rainfall record superceded its previous greatest rainfall of 271·7 mm registered on 21 October, 1963 (Meteorological Department, 1972). The total rainfall recorded at some stations during the period studied is listed in Table 2.

5. Satellite coverage

Figs. 13(a) and 13(b) illustrate the enlarged version of the satellite ESSA 8 photograph coverage for 6 and 7 January 1975. It is seen from Table 2

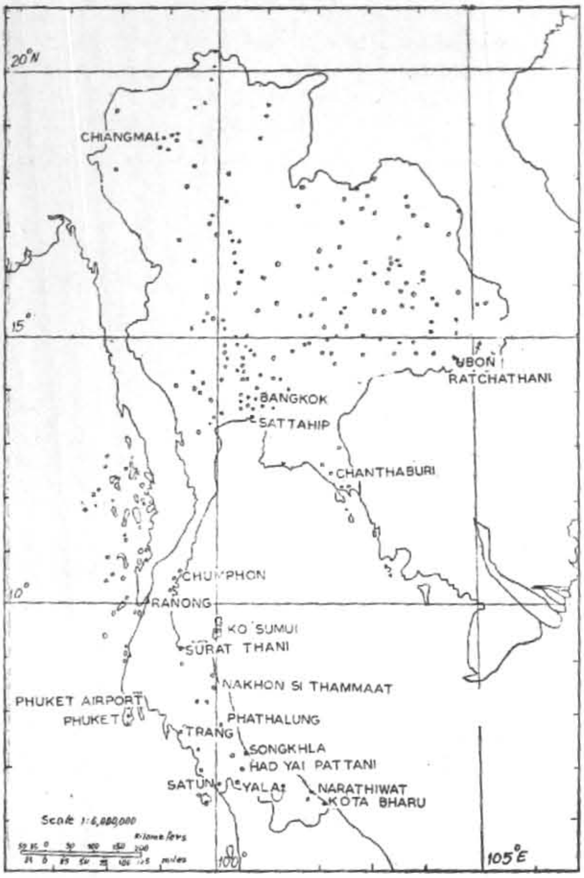

Fig. 1. Map of Thailand showing places mentioned in text

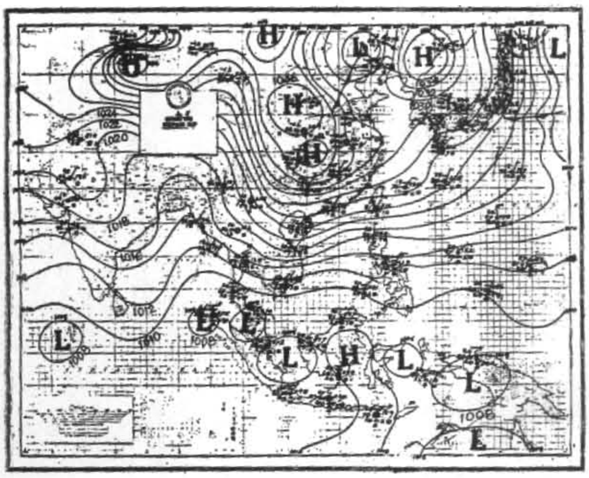

Fig. 2. Surface synoptic chart for 0000 GMT, 4 January 1975

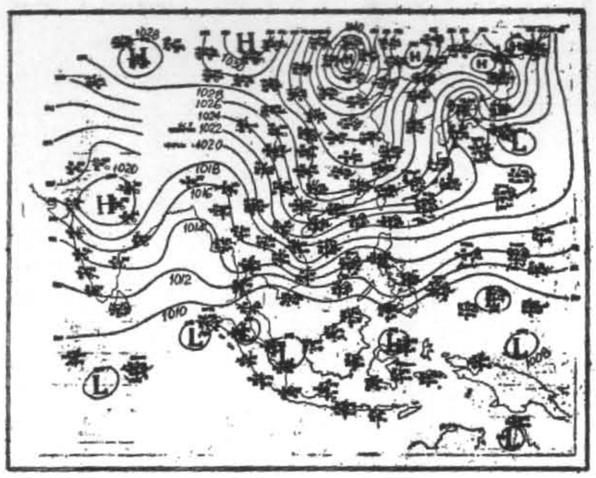

Fig. 3. Surface synoptic chart for 0000 GMT, 5 January 1975

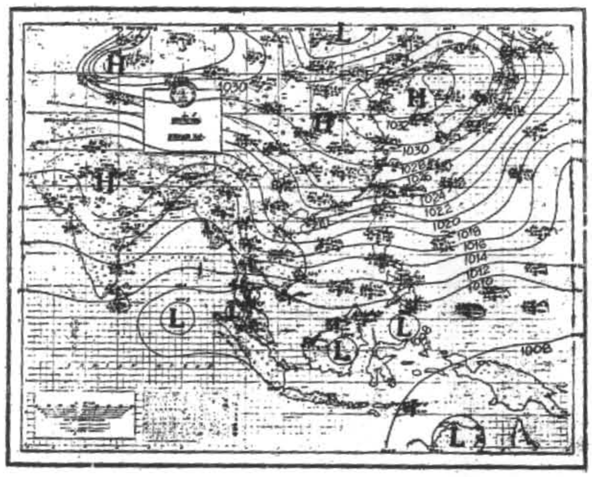

Fig. 4. Surface synoptic chart for 0000 GMT, 6 January 1975

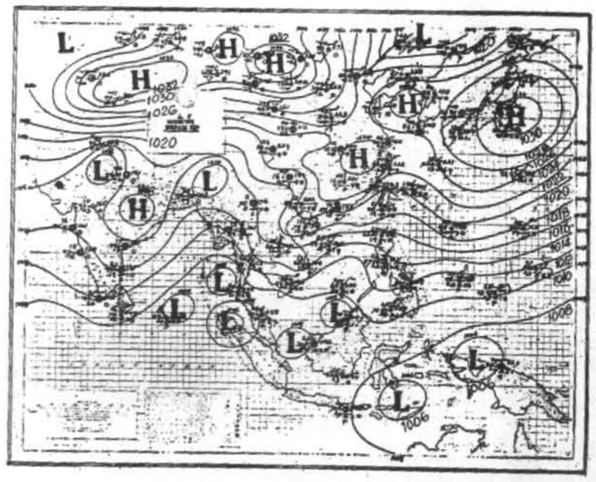

Fig. 5. Surface synoptic chart for 0000 GMT, 7 January 1975

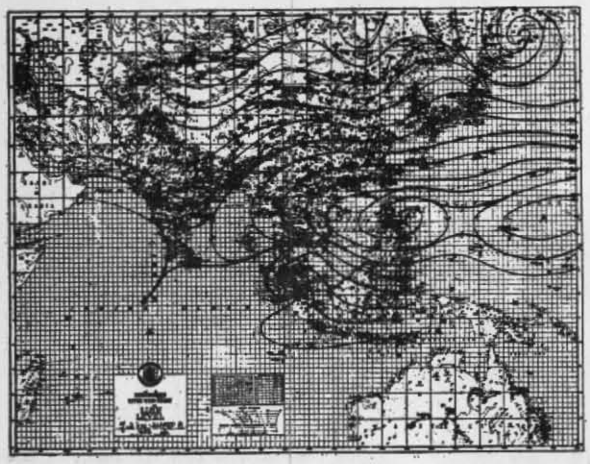

Fig. 6. 400-mb streamline chart for 0000 GMT, 4 January 1975

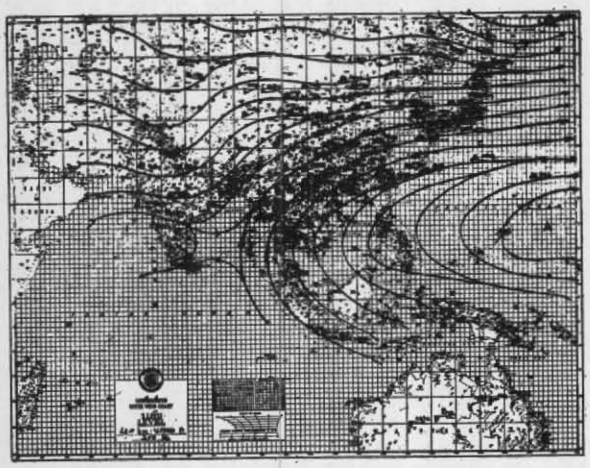

Fig. 7. 200-mb streamline chart for 0000 GMT, 4 January 1975

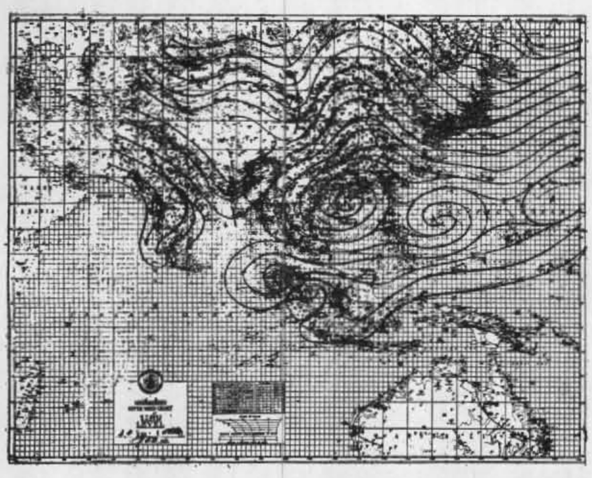

Fig. 8. 700-mb streamline chart for 0000 GMT, 5 January 1975

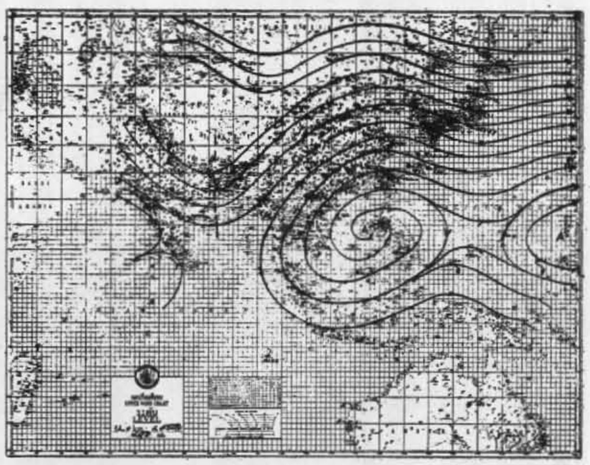

Fig. 9. 200-mb streamline chart for 0000 GMT, 5 January 1975

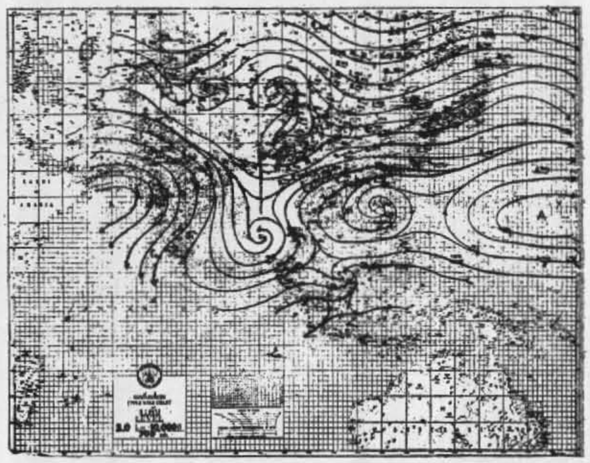

Fig. 10. 700-mb streamline chart for 0000 GMT, 7 January 1975

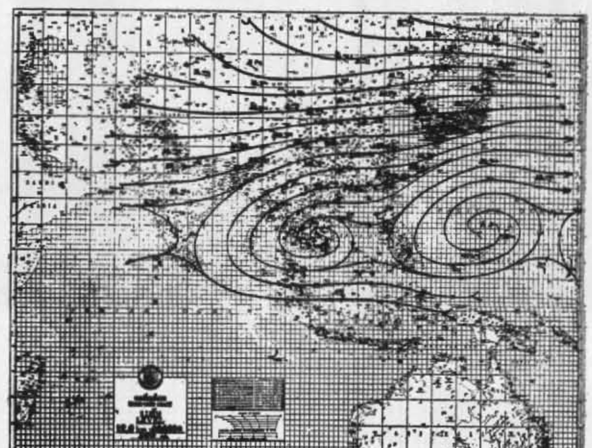

Fig. 11. 200-mb streamline chart for 0000 GMT, 7 January 1975

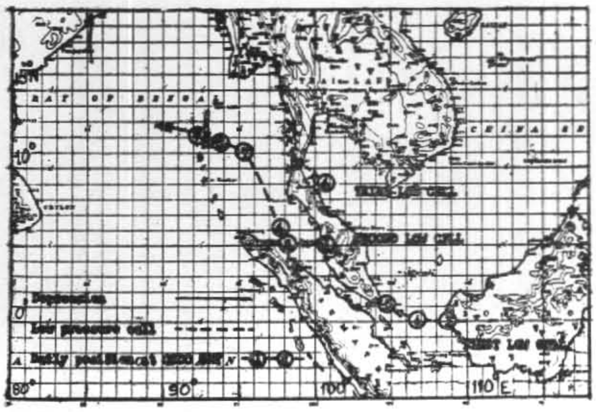

Fig. 12. Active low pressure cell tracks—3 to 9 January 1975

Fig. 13 (a). Satellite photograph from ESSA 8 between 0309 and 0332 GMT, 6 January 1975 (orbit No. 27775)

Fig. 13 (b). Satellite photograph from ESSA 8 between 0207 and 0420 GMT, 7 January 1975 (orbit Nos. 27787-27788)

that little rain fell over the extreme south and the west coast of Southern Thailand but northward portions from Nakhon Si Thamarat were large. Close examination of the picture (Fig. 13a) shows the large cumulonimbus conglomerate cells lying over the whole of central and northern parts of Southern Thailand. A depression with its clearly marked circulation is apparent over the Andaman Sea (Fig. 13 b).

6. Meteorological radar observations

Radar WTR-2 with 5·6 cm wavelength and maximum range 300 km was used to observe weather at the radar station in Songkhla. Fig. 14(a) to Fig. 14(d) show the precipitation echoes of the days as available during the period of study. It is seen from Table 2 that most of the very heavy rain fell in Southern Thailand East Coast. The particular note is the fall of 368·7 mm

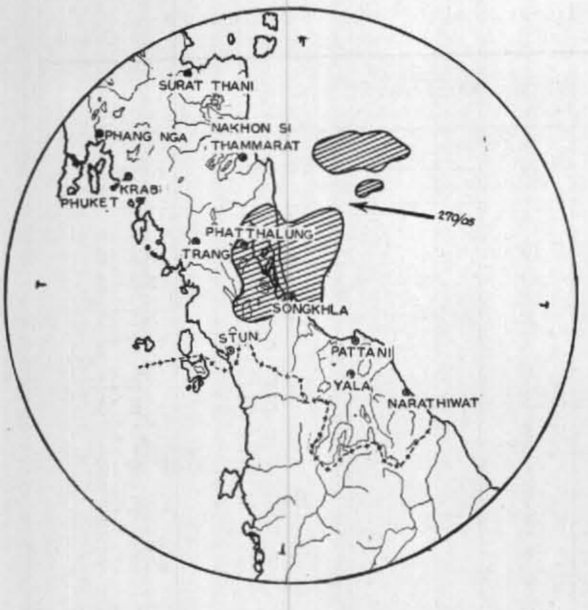

Fig. 14 (a). Radar weather observation for 0300 GMT, 4 January 1975

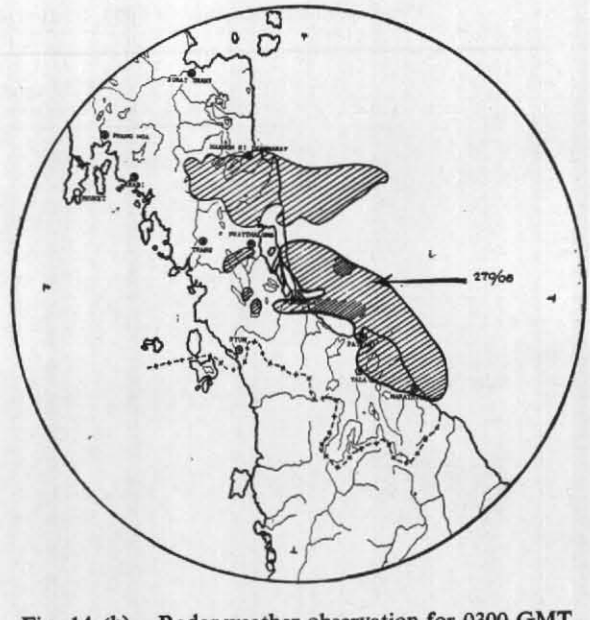

Fig. 14 (b). Radar weather observation for 0300 GMT, 5 January 1975

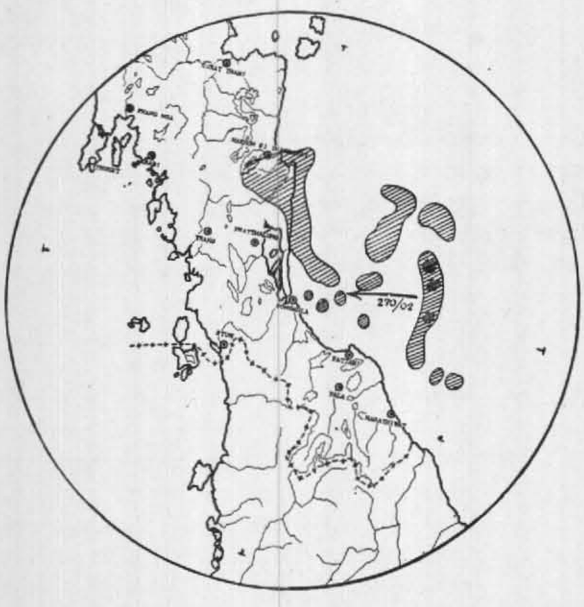

Fig. 14 (c). Radar weather observation for 0300 GMT, 6 January 1975

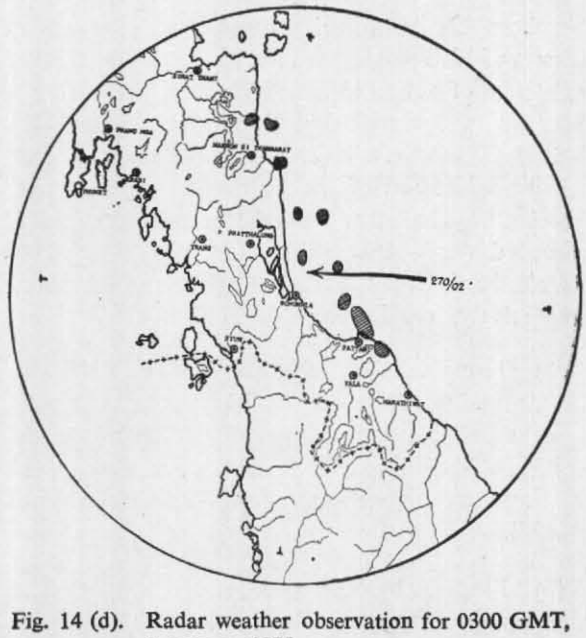

Fig. 14 (d). Radar weather observation for 0300 GMT, 7 January 1975

on the 4th at Trang, which is situated in the west coast of the country. This may be seen from Fig. 14(a). It shows the precipitation echoes pattern indicating a considerable degree of convective activity which can readily be viewed on the PPI scope and the echo moved easterly in the direction to Trang at about 5 knots. On 5 January, two large cells of precipitation echoes appeared over most of the stations along the east coast (Fig. 14b). During the next two days, the echoes pattern appeared as scatter small cells moving slowly westwards at about 2 knots (Figs. 14c and 14d).

7. Discussion and Conclusions

Some tentative conclusions may be drawn from this study :

(1) The exceptionally heavy rain recorded in

TABLE 4

Wind speed and direction at 2000 ft at selected stations during the period 3-8 January 1975

Date (Jan. 1975)	Time (GMT)	Wind direction and speed (kt) at selected stations					
		Ubon Ratchathani	Bangkok	Sattahip	Chanthaburi	Songkhla	Kotabaru
3	0000	NE 25	NE 10	NE 25	NE 25	NE 15	NE 10
	1200	NE 30	NE 10	NE 20	NE 25	NE 10	NE 15
4	0000	NE 45	NE 30	*	NE 40	NE 20	NE 30
	1200	NE 25	NE 10	*	*	E 30	E 30
5	0000	NE 25	NE 20	NE 30	NE 40	E 25	E 25
	1200	NE 20	NE 10	NE 25	NE 25	E 25	E 30
6	0000	NE 30	NE 15	NE 25	NE 40	SE 15	*
	1200	NE 15	NE 20	*	NE 35	ESE 20	ESE 10
7	0000	NE 10	NNE 10	NE 15	E 20	ESE 25	ESE 20
	1200	N 5	NE 5	NE 20	NE 10	E 25	*
8	0000	NE 5	NE 10	NE 10	NE 25	E 25	ESE 20
	1200	N 5	NE 10	NE 5	NE 10	ESE 25	*

*Data not available.

Southern Thailand during the northeast monsoon season of 1975 was caused mainly by the prolonged existence of active low cells in an area south of Southern Thailand and Malaysia bounded by latitudes 0°—9°N. This weather situation induced the intensification of the northeast monsoon over Thailand. The strong northeast monsoon winds recorded were—45kt, 40kt, 30kt, 30kt at Ubol Ratchathani, Chanthaburi, Bangkok and Kotabaru respectively, on January 4 (Table 4).

(2) Trough at 700 mb near 85°E and 95°E over Burma and northern Bay of Bengal, and a depression moving westnorthwestwards then northnorthwestwards from the Andaman Sea also appear to have an important effect on intensity of rainfall.

(3) Findings by other workers are supported in this study. Synoptic features which show the circulation in the layer of the atmosphere below 500 mb appear to control the weather and seem to have the most direct effect upon distribution of rainfall (Raghavan 1973). Convergence below 500 mb superimposed by the anticyclonic activity or divergence at 200 mb layer which could have enhanced the vertical motion, would appear to be the main mechanism for the heavy rains. The circulation in the upper troposphere contributes to the generation and intensification of the depression as well as to its movement (Koteswaram and George 1958). Orography is also an important determinant of rainfall (Ramage 1971).

(4) The intensified northeast monsoon phenomenon depends, therefore, mainly on cyclonic disturbances in the equatorial low-pressure belt for both its genesis and persistence. The causes of these cyclonic disturbances and factors that determine their intensification, the life times of duration and direction of movement will be the subject of future studies.

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