Indian J. Met. Hydrol. Geophys. (1978), **29**, 1 & 2, 419-424

551.553.21 : 551.515 (267-17)

Forecast five days ahead of the development of low pressure areas and depressions/storms over the northern part of the Bay of Bengal during the southwest monsoon season

M. N. AHMED

Main Meteorological Office, Chittagong Airport, Chittagong, Bangladesh

ABSTRACT. During the months of June, July, August and September, low pressure areas form with some regularity over the north Bay of Bengal. Most of these low pressure areas concentrate into depressions. Some of them even intensify into cyclonic storms. During the period from 1950 to 1975, 289 depressions/storms formed in the Bay. In this period 163 out of these 289 depressions/storms occurred during the S.W. monsoon months June to September. The low pressure areas not reaching the stage of depressions have been left out of this account. The lows formed but not developed upto the stage of depressions have been accounted for the months June to September of the years 1971 to 1975. These lows and the depressions/storms were found occurring at regular intervals. A somewhat periodicity was maintained in their appearance.

Pressure curves showing daily variations of pressure of Chittagong in the months June to September of the years 1971 to 1975 were made. The 0000 GMT mean sea level pressures were taken for the purpose. These curves were found in waveforms. Each wave has the length, amplitude and period. The maximum and minimum of the pressures, *i.e.*, wave crest and wave trough or the ridge and trough in the wave were found significant in view of the weather the place experienced during the period of the wave. The period of the wave was observed to be about 5 days. In case of a serious abnormality in any cyclonic circulation, the 'period' of the particular wave was disturbed. The cyclonic circulations developing into lows of pressure and depressions in the Bay fitted fairly satisfactorily in the wave troughs. The coming wave crest and wave trough in the pressure curve may be worked out.

1. Introduction : Synoptic situations over Bangladesh and neighbouring countries during the southwest monsoon months

(*a*) *Chief features of sea level pressure distribution*

The northern India seasonal low generally extends trough to NW angle of the Bay of Bengal across Bihar and Orissa. The system periodically shifts northward and to the extreme position the trough line runs along the foot of the Himalaya upto Assam. The trough of the seasonal low is occasionally extended to the NE Bay of Bengal.

Sometimes easterly low pressure areas move to NE Bay/east central Bay across upper/central Burma. Surface winds at Chittagong in June, July, August and September are mainly SE/S (Table 1).

(*b*) *Chief features of upper air temperatures distribution*

(*i*) A warm area at 500 mb level and above over the Andaman Sea in May, gradually shifts northwestwards with the advance of the monsoon. During the northwestward shifts the level of the warm area rises. In July it is prominent at 100 mb level over the Gujarat-Saurashtra-Rajasthan area.

(*ii*) After the monsoon establishes itself over the region, there is little temperature gradient below 300 mb level.

TABLE 1
Surface and upper winds

(Prevailing directions and average speeds in mph)
CHITTAGONG Lat. 22°-21′N, Long. 91°-50′E,

Height (a.s.l.)	June	Jul.	Aug.	Sep.
13000 ft	Var	SE	SE	SE
	14	15	12	12
10000 ft	Var. SSE	SSE	SSE	SE
	15	16	13	12
6600 ft	SSW	S	SSE	SSE
	17	18	15	13
3300 ft	S	S	S	S
	19	22	18	13
1600 ft (M)	S	S	S	S
	21	23	19	14
1600 ft (A)	S	S	S	S
	20	21	18	12
Surface (M)	SE	SE	SE	SE
	6	7	6	5
Surface (A)	S	S	SSW	SSW
	8	8	7	7

M=Morning A=Afternoon

(*iii*) Over the Tibetan plateau a warm area lies at the 500 mb level (1-2 km above the general level of land). This is the effect of heating of the vast land mass.

(*c*) *Chief features of the upper wind distribution*

During the monsoon months India and specially its southern region and the Bay of Bengal are swept by SW'ly/westerly winds in the levels upto 3 km. In southern Bangladesh and adjoining Bay area, from surface to levels upto 3-4 km, S/SSE and SE'ly winds prevail (Table 1). In the northern periphery of the monsoon trough the winds tend to become easterly. These winds are originally SE and NE trades having a long travel over the sea and curving clockwise becomes SE'ly and ESE/E'ly over Bangladesh and neighbourhood.

In the lower levels upto about 3 km, winds are stronger in the Indian Peninsula than in north India. At 6 km the winds over the Peninsula become light and variable and at greater heights they are easterly. At 9 km the strongest easterlies are about 10 kt and easterlies extend as far as 20°N; while at 12 km they rise to 30 kt and extend to 23°N.

At 9 and 12 km the westerlies in the north have resultant speeds of 30-40 kt; they get displaced northward with height by easterlies which at 16 km extend to 30°N. Between the latitudes of 8° and 18°N, the easterlies have resultant speeds of about 60 kt.

With the strengthening of the monsoon and its penetration further north, the southwesterlies/westerlies over the Indian Peninsula at levels upto 3 km, are of the order of 20-30 kt and the easterlies continue to strengthen from 9 to 16 km. At 16 km the speeds are of the order of 80 kt between latitudes 13°N and 17°N and easterlies extend as far as 30°N.

2. Formation of lows of pressure and depressions/storms

During the southwest monsoon months, lows of pressures and depressions form with regularity in the north Bay of Bengal. Some of the depressions even intensify into a cyclonic storm. An account of the depressions and storms for the years from 1950 to 1975 shows that 289 depressions/storms occurred in the Bay. 163 out of these 289 depressions/storms occurred during the months June to September (Table 2). The lows of pressures not reaching the stage of depressions were not taken into account. From the available weather charts for the years 1971-75 an account was made of these lows of pressures not reaching the stage of depressions. A statement showing number of lows, depressions and cyclonic storms developed during the monsoon months in the years 1971-75 is given in Table 3. From this account, it is found that 4 to 5 surface closed cyclonic circulations developed in every month. They occurred at regular intervals. A periodicity was maintained in their appearance.

3. Isallobaric changes

Isallobaric changes of Chittagong and Dacca were observed round the year for long years. The daily 0000 GMT m.s.l. pressure were used in these observations. The daily variations of pressures came out in waveform. This waveform has its positive peak, *i.e.*, ridge and negative peak, *i.e.*, trough. The period of this sort of wave is found to be 5 days $\pm$1 day. Some waves also get distorted. These variations of pressures were observed to be correlated with the weather experienced in the area. The weather of the area being closely related to these variations of pressure, the observations of the behaviour of the waveform

TABLE 2

Statement showing number of depressions/storms developed in the Bay of Bengal during the ycars 1950-1975

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Total (D & C)
	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	
1950	—	—	—	—	—	—	1	—	—	1	2	—	1	—	—	—	2	1	1	—	—	1	—	1	11
1951	—	—	—	—	—	—	—	—	—	—	2	—	2	1	5	—	—	—	1	—	—	—	—	1	12
1952	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	1	—	2	1	—	1	—	—	8
1953	—	—	—	—	—	—	—	—	—	—	2	—	1	—	3	—	—	1	—	—	—	—	—	—	7
1954	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	2	1	1	—	—	—	—	—	6
1955	—	—	—	—	—	—	—	—	2	—	2	—	—	—	1	—	3	1	2	1	1	1	1	—	15
1956	—	—	1	—	—	—	1	—	—	—	2	1	1	—	3	—	2	—	—	1	—	—	—	—	12
1957	—	—	—	—	—	—	—	—	—	—	1	—	2	—	1	1	3	—	—	—	—	—	—	—	8
1958	—	—	—	—	—	—	—	—	2	1	—	—	2	—	—	—	3	—	2	2	—	2	—	—	14
1959	—	—	—	—	—	—	—	—	—	—	1	—	4	1	1	—	—	—	1	1	—	—	2	—	11
1960	1	—	—	—	—	—	—	—	—	1	—	—	1	—	3	—	1	—	—	2	—	—	1	—	10
1961	—	—	—	—	—	—	—	—	—	2	2	—	1	—	—	—	3	—	1	—	—	—	—	—	9
1962	—	—	—	—	—	—	—	—	—	2	1	—	1	—	—	—	2	1	1	1	—	1	—	1	11
1963	—	—	—	—	—	—	—	—	—	1	1	1	—	—	1	—	2	—	1	1	—	—	—	—	8
1964	—	—	—	—	—	—	—	—	1	—	—	—	1	—	3	—	1	1	2	—	1	2	—	1	13
1965	—	—	—	—	—	—	—	—	—	1	—	1	2	—	1	—	2	—	2	—	—	—	—	1	10
1966	—	1	—	—	—	—	—	—	—	1	3	—	1	—	1	—	1	—	1	1	—	4	—	2	16
1967	—	1	—	—	—	—	—	—	—	1	1	—	1	—	2	—	2	—	—	2	1	1	—	1	13
1968	—	—	—	—	—	—	—	—	—	1	2	—	2	—	3	—	—	1	—	2	—	2	1	—	14
1969	—	—	—	—	—	—	—	—	1	1	2	—	1	—	1	1	3	—	1	2	1	1	—	1	16
1970	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	1	—	1	—	—	5
1971	—	—	—	—	—	—	—	—	—	1	2	—	1	—	1	—	—	1	—	2	—	1	—	—	9
1972	—	—	—	—	—	—	—	1	—	—	1	—	1	1	2	—	—	2	1	—	—	2	—	1	12
1973	—	—	—	—	—	—	—	—	—	—	—	—	3	—	2	—	2	—	—	1	—	2	—	1	11
1974	—	—	—	—	—	—	—	—	1	—	1	1	—	—	2	1	—	1	2	—	1	1	—	—	11
1975	—	1	—	—	—	—	—	—	—	1	2	1	—	—	3	—	2	—	—	3	—	3	—	1	17
Total	1	3	1	0	0	0	2	1	8	16	31	5	33	3	40	3	37	11	22	24	5	26	5	12	289

Total : 163

D=Depression; C=Cyclonic Storm

TABLE 3

Statement showing number of lows, depressions and cyclonic storms developed in the Bay of Bengal during southwest monsoon (1971-75)

Year	June			July			August			September			Remarks
	L	D	C	L	D	C	L	D	C	L	D	C	
1971	3	2	—	5	1	—	4	1	—	4	—	1	
1972	4	1	—	3	1	1	3	2	—	3	—	2	
1973	3	—	—	—	3	—	2	2	—	2	2	—	
1974	3	1	1	3	—	—	1	2	1	4*	—	1	*1 well marked low
1975	1	2	1	5**	—	—	1	3	—	3	2	—	**One intensified into a depression over land area in Chotanagpur
1971-1975	14	6	2	16	5	1	11	10	1	16	4	4	
Total		22			22			22			24		
Mean		4.4			4.4			4.4			4 8		

L=Lows of pressures (not developed into the stage of depressions)
D=Depression (not intensified into cyclonic storm)
C=Cyclonic storm

helped in the daily forecast as well as the forecast of the weather some days ahead. As this variation of pressure is regular and maintains periodicity, it is possible to forecast the future position of the pressure condition at the place/area. The ridge and the trough of this waveform of pressure are accompanied with fair weather and bad weather respectively characteristics of the season at the place. Taking into account the amplitudes of the peaks of the waveform and the general condition of the waveform in respect of the normal pressures at the time and also the synoptic situations in the region, a forecast of weather is possible 5-6 days earlier.

Pressure curves showing daily variations of pressure at Chittagong during the southwest monsoon months June to September, were specially considered for the years 1971-75 (Figs. 1a, 1b). For this purpose, the 0000 GMT mean sea level pressures were used. In the pressure curves for the months in these years, five troughs are generally found in every month. Minor fluctuations between the waves are ignored. The account of closed cyclonic circulations developed during the months in this period (Table 3) shows that 4-5 disturbances occurred in every month.

The development of lows of pressure and depressions/storms in the northern part of the Bay of Bengal was being followed. It was found that formation of these lows and depressions/storms was correlated with the waveform. The approach and passage of the disturbances fitted fairly satisfactorily in the troughs and ridges of the waves in the pressure curves.

During the southwest monsoon months June to early September, an anticyclonic cell normally lies over Tibetan plateau at 6·0 km level and above. The easterlies prevail south of the Himalayas around the southern periphery of this anticyclonic cell and the westerlies north of the plateau around the northern periphery of the anticyclonic cell.

Western distrubances moving along further southerly latitudes than the usual track, affect the above feature distorting the anticyclonic cell. The condition causes shifting of the cell northeastward or weakening of the cell with shifts southward resulting in retardation in the movement of a monsoon depression and its recurvature and also 'breaks' of the monsoon.

Northward movement of typhoons in the southwest Pacific affects the easterly flow pattern and plays part in causing 'break' of the southwest monsoon in Bangladesh-India region.

Explanations for the cases of distortion of waves in the pressure curve are found out from action of the aforesaid obstacles in the normal flow of easterlies and westerlies.

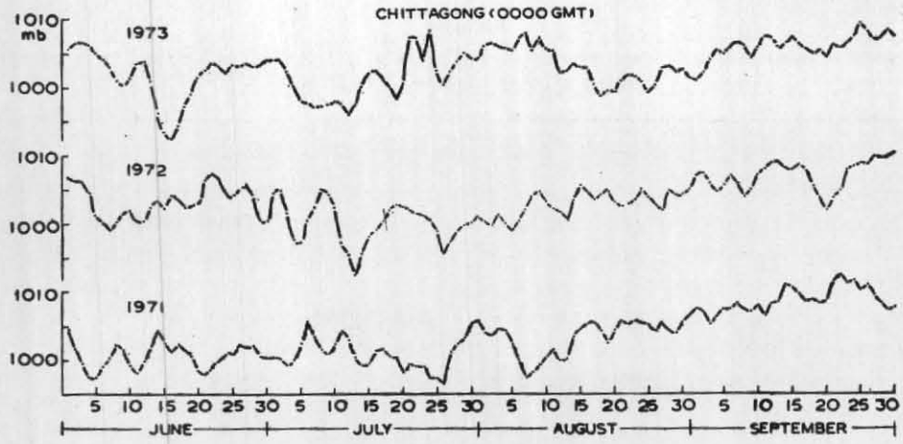

Fig. 1(a). Pressure Curve

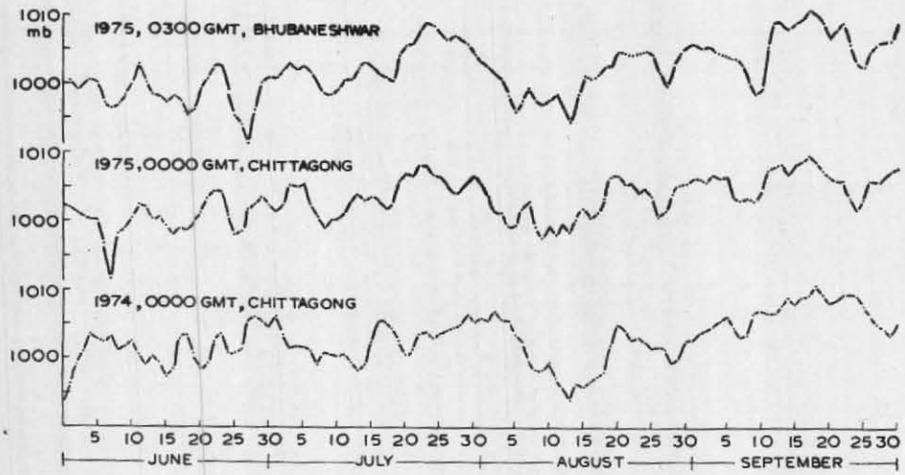

Fig. 1(b). Pressure Curve

Another point is also marked that the waves have been considered in the pressure curves of Chittagong, a place far out of the normal track of the monsoon depressions. The pressure curves of a station far inside the north Bay along a longitude say 88°E and within the general track of the lows of pressures and depressions, would give more pronounced wave trough and wave crests. But this facility is lacking.

Attempt was made to obtain the data of Chandbali, a station in Orissa coast, from the *Indian Daily Weather Reports* of June to September 1975; but full data at 0300 GMT were only available for another station Bhubaneswar inside the land area a bit away from the coast. With these data a pressure curve was drawn (Fig. 1b). A good similarity was observed between this curve and the curve of Chittagong for the period.

4. Conclusions

(1) Northern India seasonal low occasionally extends trough to NW Bay/NE Bay. Easterly low pressure areas at times move to the northern Bay of Bengal across Burma.

(2) Lower tropospheric winds are mainly southeasterly/ southerly getting easterly around the northern periphery of the monsoon trough.

(3) Upper tropospheric easterlies gain dominance over the northern Bay of Bengal, Bangladesh and neighbouring India with the onset of the southwest monsoon.

(4) Surface closed cyclonic circulations develop over the north Bay at regular intervals.

(5) The 24-hour pressure changes appear in waveforms having wave troughs and wave crests correlated with the approach and passage of the lows of pressures and depressions.

With a watch over the positions and strength of the waves in upper tropospheric easterlies and westerlies in the region, the meteorologists may utilize the pressure curve as an useful tool in forecasting 5 days ahead of development of lows of pressures and depressions/storms over the north Bay of Bengal during the southwest monsoon season and the associated rainfall in Bangladesh and along the tracks of the disturbances.

Acknowledgement

The author's thanks are due to the forecasters of the Main Meteorological Office, Chittagong Airport for testing the pressure curves in the day-to-day forecasting and also to Mr. Saaduddin Ahmed Chowdhury for assistance in the preparation of the diagrams.

REFERENCES

Dunn, G. E. and Miller, B. I. 1960 *Atlantic Hurricanes*, pp. 27-28, Louisiana State Univ. Press.

India met. Dep. 1943 *Climatological Atlas for Airmen.*

1944 *Aviation Climatological Tables*, p. 18.

1960 *Monsoons of the World.*

Reihl, H. 1954 *Tropical Meteorology.* McGraw-Hill Book Co., New York.