LETTER TO THE EDITOR

Cyclogenesis in the Bay of Bengal and Arabian Sea

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1. Introduction

Mowla (1968) has stated that normal isotherms of 200 mb level over the sea area bear some remarkable similarity with the isocyclogenesis lines in the Bay of Bengal and the Arabian Sea pertaining to the same seasons. He has reproduced normal June and July 200 mb level isotherms in Figs. 1*b* and 2 respectively of his paper from Ramakrishnan (1958) and also shown in Fig. 1*b* the frequency of storms and depressions during the months June to September from the paper of Ananthakrishnan and Bhatia (1958). He has mentioned that cyclogenesis tends to occur over both the seas as well as over the land area of the Indo-Pakistan subcontinent over the area where warm pools form at the 200 mb level, the same being generally bounded by 226°A isotherms and more. Cyclogenesis in eight cases (one in June in the Arabian Sea and seven in July, August and September) and 200 mb level warm pools during 1964 have been studied and details of case study of the depression of 22nd August have also been given. He has concluded that 200 mb level warm pool which forms generally three to four days earlier can be considered as one of the causes of cyclogenesis of tropical storms and depressions.

2. Discussion

India Meteorological Department (I. Met. D.) has recently (1968) published normal upper air temperature charts during July for 850, 700, 500 and 300 mb levels. It is seen from the isotherms for 300 mb that highest temperatures occur between about 25 and 35° N and 60 and 100° E, the area having temperatures higher than 249°A. In Fig. 1 are given isotherms and winds at 200 mb level, the data having been obtained from the I. Met. D. It will be seen from the figure that the region of highest temperatures—more than 230°A—extends between about 28 and 35° N and 50 and 95° E, i.e. about the same area as at 300 mb level. In Fig. 2 of Mowla giving normal July 200 mb level isotherms the region of highest temperature—more than 226°A—occurs over the north Bay of Bengal, i.e. the highest temperatures are much further south of the area of highest temperatures in our Fig. 1. This difference is probably due to the fact that Ramakrishnan (1958) did not consider effect of the Tibetan plateau on the temperature distribution and more observations have since become available for the entire area. In view of the isotherms in our Fig. 1, it is *not* possible to accept the conclusion of Mowla that there is remarkable similarity between normal isotherms of 200 mb level over the north Bay in July and frequency of storms and depressions there during the months June to September.

In the case study of 22 August, 1964 depression he has considered 00 GMT temperatures at 200 mb level. Calcutta is the nearest radiosonde-rawin station to the north Bay of Bengal and its temperatures and winds at 200 mb level for 00 and 12 GMT for 18 to 24 August, 1964 obtained from the I. Met. D. are given in Table 1.

Although according to the temperatures given by Mowla (figures in bracket in Table 1 taken from Figs. 3*a*, *b* and *c* of his paper) for alternate days there is a rise in temperatures from the 18th to 20th to 22nd, from the temperatures for 00 GMT for each day given in Table 1, it is seen that temperature rose from the 18th to 20th, fell from the 20th to 21st, rose from the 21st to 22nd, was about the same on the 23rd and fell from the 23rd to 24th.

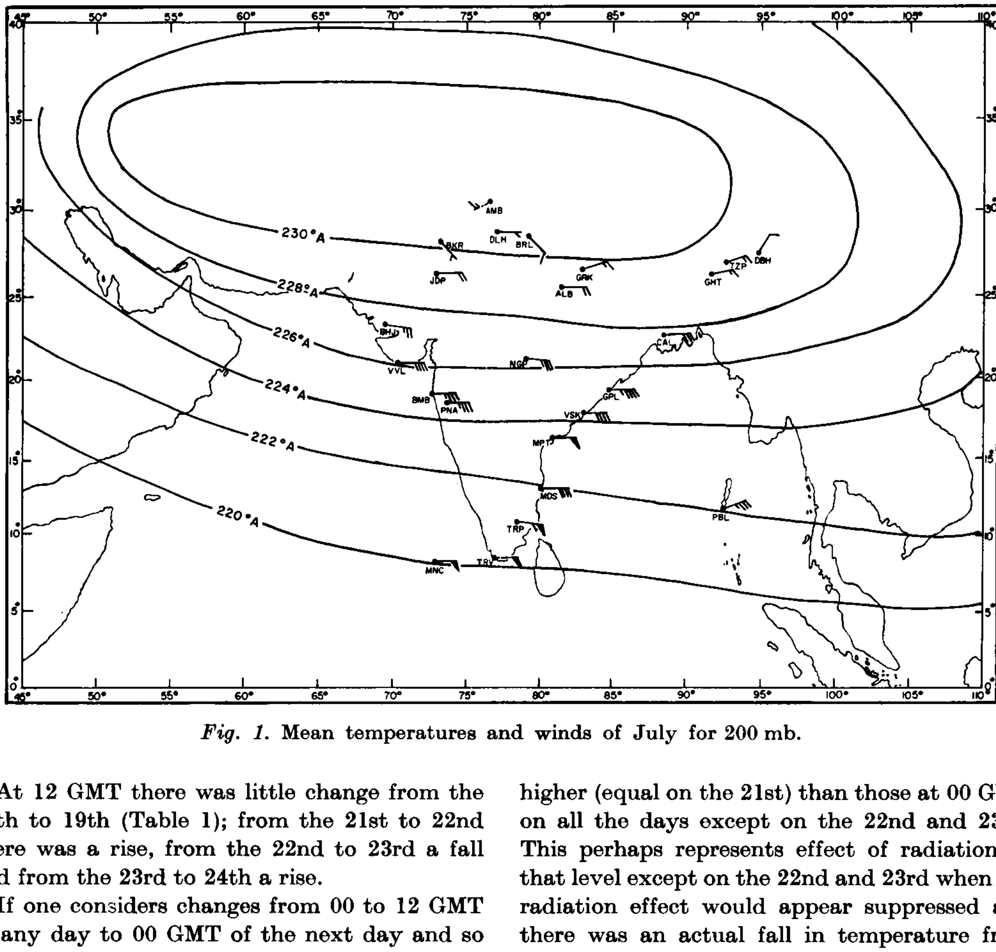

Fig. 1. Mean temperatures and winds of July for 200 mb.

At 12 GMT there was little change from the 18th to 19th (Table 1); from the 21st to 22nd there was a rise, from the 22nd to 23rd a fall and from the 23rd to 24th a rise.

If one considers changes from 00 to 12 GMT of any day to 00 GMT of the next day and so on, it will be seen from the Table that there is no regular rise from day to day till the 22nd. Temperatures at 12 GMT were generally higher (equal on the 21st) than those at 00 GMT on all the days except on the 22nd and 23rd. This perhaps represents effect of radiation at that level except on the 22nd and 23rd when the radiation effect would appear suppressed and there was an actual fall in temperature from 00 to 12 GMT. There is no regular fall in temperature from 12 GMT of any day to 00 GMT of the next day; temperatures rose from 12 GMT of the 21st and 22nd to 00 GMT of the 22nd and 23rd respectively and was the same at 12 GMT of the 23rd and 00 GMT of the 24th.

Table 1. *Calcutta Temperatures and Winds at 200 mb level in Aug. 1964.*

	00 GMT			12 GMT		
	Temp.	Wind		Temp.	Wind	
		D	V		D	V
	(°C)	(°)	(m.p.s.)	(°C)	(°)	(m.p.s)
18	−53 (−53)	065	6.5	−40	060	16.5
19	−48	095	17.0	−41	065	16.0
20	−44 (−43)	070	18.0	—	—	—
21	−48	—	—	−48	070	5.0
22	−39 (−39)	045	13.5	−44	360	9.5
23	−39	085	4.0	−45	050	6.0
24	−45	090	12.0	−41	145	3.0

From the data in Table 1 it can be stated that there was no regular and persistent development of a warm pool at 200 mb three to four days before the formation of the depression on the 22nd August, 1964.

In Table 2 of his paper Mowla (1968) has given the values of isotherms (Row No. 1) which surrounded the warm pool at 200 mb level associated with the formation of depressions and also indicated (Row No. 2) the intensity of the warm pools one day before the formation of the depression. For the depression of 22nd August 233°A is given in both the Rows 1 and 2. Calcutta temperatures at 00 GMT on the 22nd was

−39°C, but −48°C on the 21st although it was −39°C on the 23rd as seen from Table 1 above. As the temperature on the 21st was −48°C (Table 1) it is not clear how Mowla has given temperature of −40°C (233°A) for that day.

It is seen from Mowla's Table 2 that while the warm pool temperature was lower on the day of formation of the depression than on the previous day in the cases of 9th June and 4th and 10th August, it was higher on 3rd July and 7th and 22nd September, being the same on the 15th and 22nd August. It is considered that it is not safe to draw conclusions from such variations in temperatures one day before and on the day of formation of the depression.

From a study of the synoptic charts it is seen that between the 17th and 18th, a low pressure wave was moving westwards through upper Burma, and the Bay monsoon began to strengthen under its influence; Akyab had 11 cm rain and Chittagong 6 between the 18th and 19th. Heavy rain again fell on the Chittagong-Arakan coast during the next 24 hrs. By the 21st morning, weather was unsettled over the northeast Bay off Arakan-Chittagong coast. The region of unsettled weather moved westwards and a depression formed near 21.5° N, 88.5° E at 03 GMT of the 22nd, the cyclonic circulation extending to 6.0 km at least.

From the normal distribution of temperatures at 200 mb given in Fig. 1 one will be inclined to think that air with southerly component over Calcutta will be colder than that with northerly component. On examining temperatures and winds over Calcutta given in Table 1 it will, however, appear that no such regular relation is observed except at 00 GMT from the 19th to 20th. Similarly there is no regular relation between temperature and wind changes from 00 to 12 GMT of the day or from 12 GMT of any day to 00 GMT of the next day. It would thus appear that interpretation of day to day changes in temperature with reference to wind at 200 mb is not easy.

It is not possible to state that the passage of a low pressure wave or of a ridge at 200 mb level was responsible for the formation of the depression on the 22nd. One of the authors (Desai, 1968), has discussed the conditions which favour formation of depressions in the north Bay during the months June to September. Movement of pressure systems at 200 mb level would *not* appear to have cause-effect relation with developments at the surface or in the lower troposphere although in some cases it might appear so (Desai, 1969). The pressure pattern developing in the lower troposphere represents integrated effect of various factors and *not* of any individual factor.

The hitherto prevailing idea that temperatures fall in the rear of the troughs moving in the westerlies in the middle and upper troposphere during the months June to September would require modification in view of the upper winds and temperature charts for 500 and 300 mb given in the I. Met. D. charts (1968) and at 200 mb given in Fig. 1. As temperatures are high over the Tibetan plateau and further westwards over the highlands of Afghanistan and Iran, when the rear of the westerly troughs affects areas south of about 30° N, temperatures will rise unless there is a rush of cold air from latitudes further north of 35° N and it is able to move southwards across warmer temperatures between 35 and 30° N without any significant rise in its original temperatures. This point requires detailed examination as the effect of the rear of the westerly troughs in the middle and upper troposphere is believed to weaken or lead to disappearance of the monsoon trough at the surface and break in the monsoon rains (Ramaswamy, 1962, 1969). In this connection, a reference is invited to papers of Changraney (1966) and Desai (1967) according to which the monsoon trough may even get accentuated by the movement of the troughs in the westerlies.

3. Concluding Remarks

It would appear from the foregoing discussion that it is not possible to accept Mowla's conclusions about development of warm pools at 200 mb level three to four days before the depression forms at sea level below them. It is difficult to interpret temperature wind changes at 200 mb level due to area of high temperatures over Tibet and westwards; Mowla's statement about movement of cold trough in the westerlies across north India extending upto 28° N on the 18th and 19th August and of a cold trough in the easterlies which extended upto 26° N on the 19th has, therefore, to be considered with utmost caution from the point of day to day forecasting.

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