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SOUTHERN HEMISPHERE INFLUENCE ON INDIAN RAINFALL

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ABSTRACT

An examination of the pressure variations on either side of the equator suggests that the southern hemisphere High in the west Indian ocean is normally capable of influencing the sea level pressure across the equator as far as upto about lat. 12°N over Kerala during the mid-monsoon months July and August. This is reflected in the high positive correlation between the monthly mean sea level pressure of Fort Dauphin in July and Kerala in August. This interhemispheric pressure variation seems to have some control over the August rainfall over Kerala because we are able to predict the total August rainfall with an accuracy of ± 30 percent, through the usual regression technique, on 87 percent of the years when August rainfall lies within 50 percent of the normal. Large variations of rainfall beyond 50 percent of the normal leading to floods or droughts are apparently unrelated to the pressure changes taking place in the southern hemisphere for in these years the predicted rainfalls are far from the actual.

1. Introduction

During the period June to September the SE trades cross

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the equator and blow across the westcoast of India as the SW monsoon current. These trades are part of the circulation in the southern hemisphere High in the West Indian Ocean (Fig.1). The High undergoes large variations in intensity particularly during the months July and August when it is mid-winter in the southern hemisphere. Associated with its variations we can expect a change in the depth and steadiness of the trades atleast in the southern hemisphere about which we have hardly any precise idea. If the High intensifies and induces an increase of pressure upto the equator or beyond, it is possible that the weather in the region of increasing pressure tends to resemble the fair weather which usually prevails in the regime of the High. Eventually when the High weakens the weather in the region of decreasing pressure may tend to deteriorate. With the available sea level pressure data attempt has been made first to get a broad idea of the northern limit of the pressure variations associated with the fluctuations in the intensity of the High and then to understand the influence, if any, of these fluctuations on the rainfall of the Indian westcoast where the trades are usually recognised as the main rain-bearing current of the season.

2. Data and analysis

Fort Dauphin (Fig.1) in Malagasy (Madagascar) is considered to represent the west Indian ocean southern

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hemisphere High. Its mean monthly sea level pressure data pertain to the period 1941 to 1971. Along the Indian westcoast data for the corresponding period are readily available for Cochin (lat. 10°N), Mangalore (lat. 13°N) and Bombay (lat. 19°N). The correlation coefficients between the mean monthly sea level pressure for these westcoast stations and Fort Dauphin have been worked out. In Tables I to III are given the lag correlations from May to September.

3. Inter-hemispheric pressure variations

Table I shows that the sea level pressure variations at Fort Dauphin for none of the monsoon months except for July bear a significant relation with the pressure variations at Cochin. Fort Dauphin July pressure is highly related to the August pressure of Cochin (c.c. : + 0.699, significant at 1 percent level).

Table I : C.C. between Fort Dauphin and Cochin sea level pressure

Fort Dauphin	Cochin				
	May	June	July	August	Sept.
May	.094	-.200	.131	-.111	-.247
June		-.018	-.113	-.384	-.308
July			.251	.699	.330
August				.211	.422
September					.392

North of Cochin at Mangalore the correlation coefficient is generally negligible and therefore its pressure variations can be considered as indifferent to Fort Dauphin pressure for all the months May to September (Table II). This is more or less true in regard to Bombay also (Table III). Similar study had been made, out of curiosity, in respect of Madras (lat. 13°N) in the eastcoast and it was found that the correlations were small and negligible.

Table II : C.C. between Fort Dauphin and Mangalore sea level pressure

	Mangalore				
Fort Dauphin	May	June	July	August	Sept.
May	-.119	-.232	-.073	-.178	-.327
June		.009	.018	-.033	.105
July			.142	.112	-.008
August				-.146	.087
September					.017

In order to see the northernmost latitude beyond Cochin where there is significant relation between July pressure of Fort Dauphin and August pressure along the west coast, Cochin and Mangalore correlation coefficients have been interpolated. At about lat. 12°N which marks nearly the northern boundary of Kerala the correlation coefficient

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is about + 0.38 (significant at 5 percent level).

Table III : C.C. between Fort Dauphin and Bombay sea level pressure

	Bombay				
Fort Dauphin	May	June	July	August	Sept.
May	.041	-.109	.072	-.203	-.180
June		-.074	.158	-.054	.050
July			-.032	.276	.308
August				-.173	.156
September					.100

4. Southern hemisphere pressure and Kerala rainfall

Encouraged by the significant correlation between Fort Dauphin July pressure and Kerala August pressure, we have worked out a regression equation using Fort Dauphin July pressure as predictor and Kerala August rainfall as predictant. Kerala August rainfall has a correlation of -0.315 with Fort Dauphin July pressure. The regression equation to predict Kerala August total rainfall

$R = 37.2 + (-3.385)\ (P - \overline{P})$ where P and $\overline{P}$ are respectively the mean monthly and normal sea level pressure in July at Fort Dauphin. According to this regression equation the predicted rainfall in August was within $\pm$ 20 percent of the actual rainfall in 39 percent of the years (1941-1971).

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During these 31 years unusual rainfalls with 50 percent or more departure from normal occurred in Kerala in 8 years. If we ignore these unusual years, the percentage of prediction considerably improves from 30 percent to 52 percent while the success of prediction is as high as 87 percent within a margin of ± 30 percent of the actual rainfall.

It was significant to note that in 23 percent of the total 31 years, the predicted rainfall was more than 50 percent in excess of the actual rainfall. Table IV shows that these were the years when the rainfall in Kerala was remarkably below normal characteristic of drought conditions. August rainfall in Kerala is expected to be below normal

Table IV : Subnormal rainfall in Kerala in August and Fort Dauphin pressure in July.

Year	Actual rainfall – Amount (Cm)	Actual rainfall – Percent departure from normal	Predicted rainfall – Amount (Cm)	Predicted rainfall – Percent departure from the actual rainfall	Fort Dauphin pressure Departure (mb)
1943	18	- 51	35	+ 94	+ 0.64
1944	22	- 41	35	+ 60	+ 0.64
1951	11	- 71	35	+218	+ 0.64
1953	15	- 60	32	+100	+ 1.64
1955	12	- 68	38	+200	- 0.35
1956	22	- 41	38	+ 74	- 0.35
1966	19	- 50	42	+120	- 1.35

XXXXXXXXXXXXXX (normal 37.2 cm based on data for 31 years) when Fort Dauphin pressure departure is positive. In the years 1943, 1944, 1951 and 1953 Fort Dauphin pressure departures were positive and consequently the prediction formula indicated below normal rainfall in Kerala. But the actual rainfall was so much below normal (40 to 70 percent) that the prediction failed in these years. In 1955, 1956 and 1966 Fort Dauphin pressure departures were negative which indicated, according to the prediction formula, above normal rainfall. Actually the rainfall was about 40 to 70 percent below normal and the prediction failed over a wide margin (74 to 200 percent). This shows that large defeciency of rainfall in Kerala during August is not related to the pressure variations in the west Indian ocean of the southern hemisphere. This lends support to the view that severe break-monsoon conditions (drought) over India are brought about by circulation changes whtin the Indian region itself and not by global circulation changes (Raghavan 1973).

The prediction formula was equally a failure in the years when the rainfall was far above normal (Table V). The predicted amounts were nearly 40 percent less than the actual rainfall. This shows that large abnormal rainfall, as in the case of large subnormal rainfall, in Kerala during August is not intimately related to the pressure variations in the southern hemisphere. On the other hand, both the subnormal and abnormal rainfalls exhibited intimate association with the circulation changes in India and neighbourhood.

Table V : Abnormal rainfall in Kerala in August and Fort Dauphin pressure in July

Year	Actual rainfall		Predicated rainfall		Fort Dauphin pressure Departure (mb)
	Amount (Cm)	Percent departure from normal	Amount (Cm)	Percent departure from the actual rainfall	
1946	65	+ 75	38	- 42	- 0.35
1947	74	+ 99	45	- 40	- 2.35
1961	63	+ 70	38	- 39	- 0.35

5. Summary and remarks

This study with limited data suggests that the southern hemisphere High in the west Indian ocean is normally capable of influencing the sea level pressure across the equator as far as upto about lat. 12°N over Kerala during the mid-monsoon months July and August. This is reflected in the high positive correlation between the monthly mean sea level pressures of Fort Dauphin in July and Kerala in August. This inter-hemispheric pressure variation seems to have some control over August rainfall over Kerala because we are able to predict the total August rainfall with an accuracy of $\pm$ 30 percent, through the usual regression technique, on 87 percent of the years when August rainfall lies within 50 percent of the normal. Large

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variations of rainfall beyond 50 percent of the normal leading to floods or droughts are apparently unrelated to the pressure changes taking place in the southern hemisphere for in these years the predicted rainfalls are far from the actual. This viewed in the light of similar results of long-range forecasting of rainfall for other parts of India based on the variations of centres of action in different parts of the globe (Jagannathan 1960) tempts us to believe that the development of a successful long-range prediction technique for India probably depends mainly on a proper understanding of the evolution of the regional and not global circulation changes. This implies that long-term climatic changes over regions far away from India which we apprehend in these days may not have any serious impact on the Indian rainfall in general.

Acknowledgement

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REFERENCES

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Raghavan, K.	1973	Monthly Weather Review (Washington), Vol. 101, No. 1, pp. 33-43.

Legends to diagram

Fig. 1 : Sea level pressure (mb) distribution and SE trades during the Indian summer monsoon.

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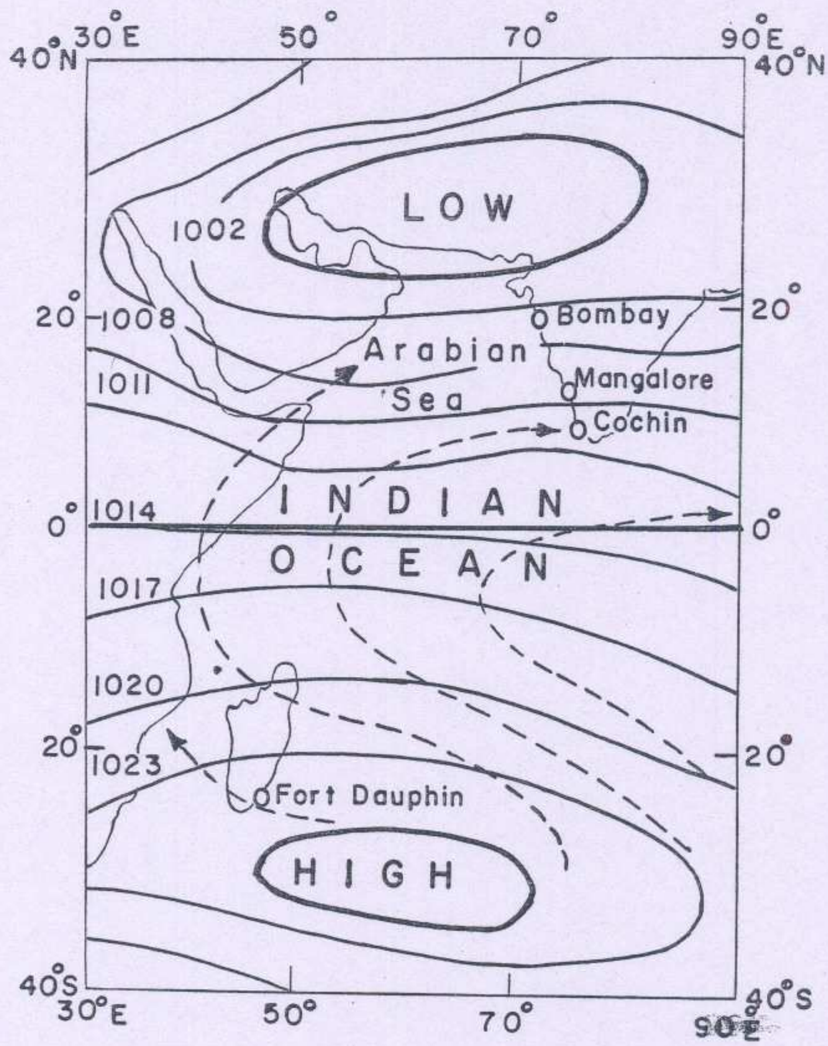

Fig. 1. Sea level pressure (mb) distribution & SE trades during Indian summer monsoon.