

5-6 days oscillations in the pressure gradients over India during SW monsoon

H. N. BHALME and S. S. PARASNIS

Indian Institute of Tropical Meteorology, Poona

(Received 16 October 1973)

ABSTRACT. The day-to-day variation in the pressure gradients over India for the SW monsoon seasons of 1961-1970 were examined by means of power spectrum analysis. There is a tendency for the spectra to show particular preference for 5-6 days period. Perhaps this period is associated with the pulsatory behaviour of SW monsoon.

1. Introduction

Despite the broad seasonal nature of wind flow as implied by the word monsoon, daily monsoon activity shows large variations. It is well known that SW monsoon rainfall which accounts for major portion of the precipitation over most parts of India, occurs in spells or pulses which is evidenced by the alternation of strong and weak monsoon conditions. The strengthening and weakening of the monsoon current is associated with fluctuations in the pressure gradients across the country. Hence pressure gradients across the country can be taken as a measure of the strength of monsoon current.

Ananthkrishnan (1970) has discussed the result of pentad analysis of surface pressure between New Delhi ($28^{\circ}35'N$, $77^{\circ}11'E$) and Nagpur ($21^{\circ}09'N$, $79^{\circ}07'E$) and between Nagpur and Trivandrum ($08^{\circ}29'N$, $76^{\circ}57'E$). He reported the manner in which the reversal of pressure gradient from winter to summer type across the country is effected and the association of surface pressure gradients with SW monsoon.

The pressure differences between New Delhi and Nagpur and between Nagpur and Trivandrum provide a measure of pressure gradient over north India and across Peninsular India respectively. Hereafter pressure difference between New Delhi and Nagpur and between Nagpur and Trivandrum will be referred to as the pressure gradient over north India and across Peninsular India respectively.

In this study, day-to-day fluctuations in the surface pressure gradients, across north India and Peninsular India for ten SW monsoon seasons of 1961-1970, have been examined by means of

power spectrum analysis to investigate if there is any periodicity.

2. Data

The daily mean sea level pressure (mean of 00 and 12 GMT) of SW monsoon period from June to September of 1961 to 1970 were utilised in this study. The daily sea level pressure for New Delhi, Nagpur and Trivandrum were extracted from *Indian Daily Weather Reports*. The daily pressure differences between New Delhi and Nagpur and between Nagpur and Trivandrum were computed for SW monsoon seasons of 1961 to 1970.

3. Spectrum analysis

For the time series of rapidly fluctuating elements power spectrum analysis has become a widely accepted technique to separate signals from noise. In recent years this tool has found wide application for the study of periodicities in the fluctuations of meteorological elements. The computational procedure outlined in the WMO Technical Note (1966) on climatic change was adopted for this study. In order to study the short period fluctuations it is necessary to remove the seasonal trend from the time series. Therefore trends and long period fluctuations more than approximately 50 days periodicity were removed by fitting of fifth degree orthogonal polynomial to 122 daily pressure gradient values of SW monsoon for each of the years of 1961-1970. The fifth degree polynomial value for each of the days was subtracted from the observed value of pressure gradient. These deviations of observed values from the polynomial trend were subjected to power spectrum analysis. The power spectra were calculated with maximum

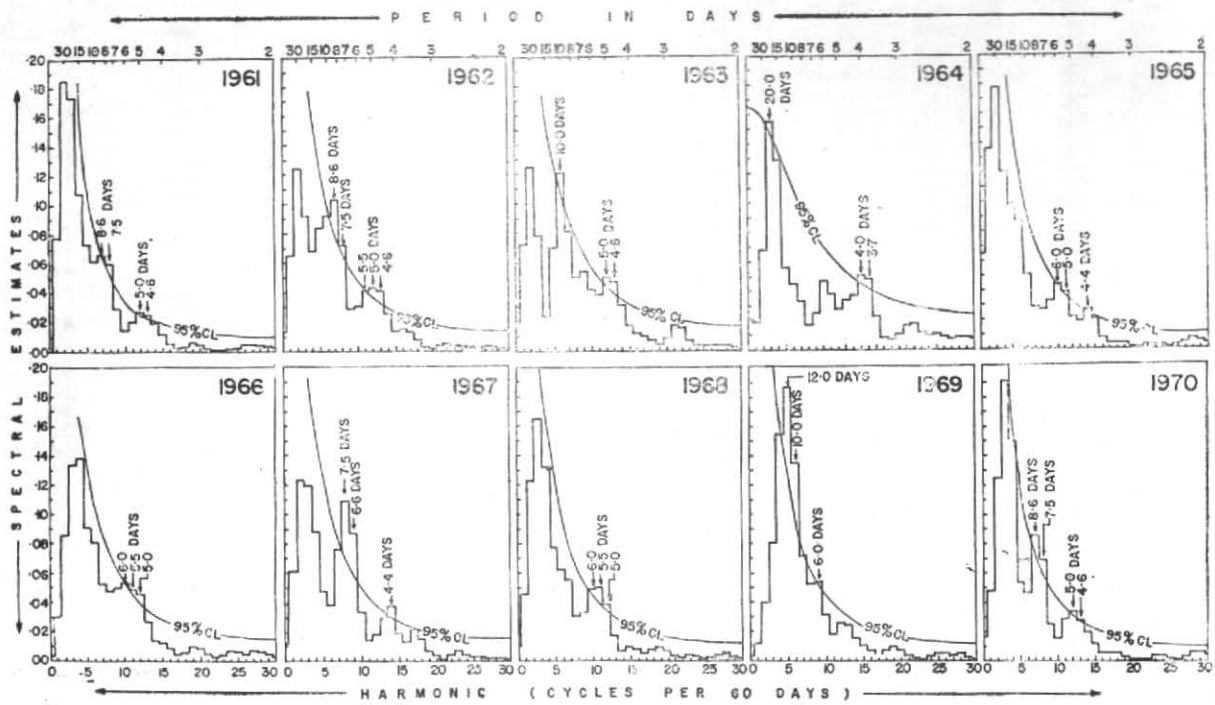


Fig. 1. Power spectra for pressure gradient over north India

TABLE 1

Count of 95 per cent level significant spectral peaks at different periods for pressure gradient over North India

Year	Period days (Harmonic)														Total
	20.0 (3)	15.0 (4)	12.0 (5)	10.0 (6)	8.6 (7)	7.5 (8)	6.6 (9)	6.0 (10)	5.5 (11)	5.0 (12)	4.6 (13)	4.4 (14)	4.0 (15)	3.7 (16)	
1961					1	1				1	1				4
1962					1	1				1	1				4
1963				1						1	1				3
1964	1												1	1	3
1965								1	1			1			3
1966								1	1	1					3
1967						1	1					1			3
1968								1	1	1					3
1969			1	1			1								3
1970					1	1				1	1				4
Total	1		1	2	3	4	2	3	3	6	4	2	1	1	33

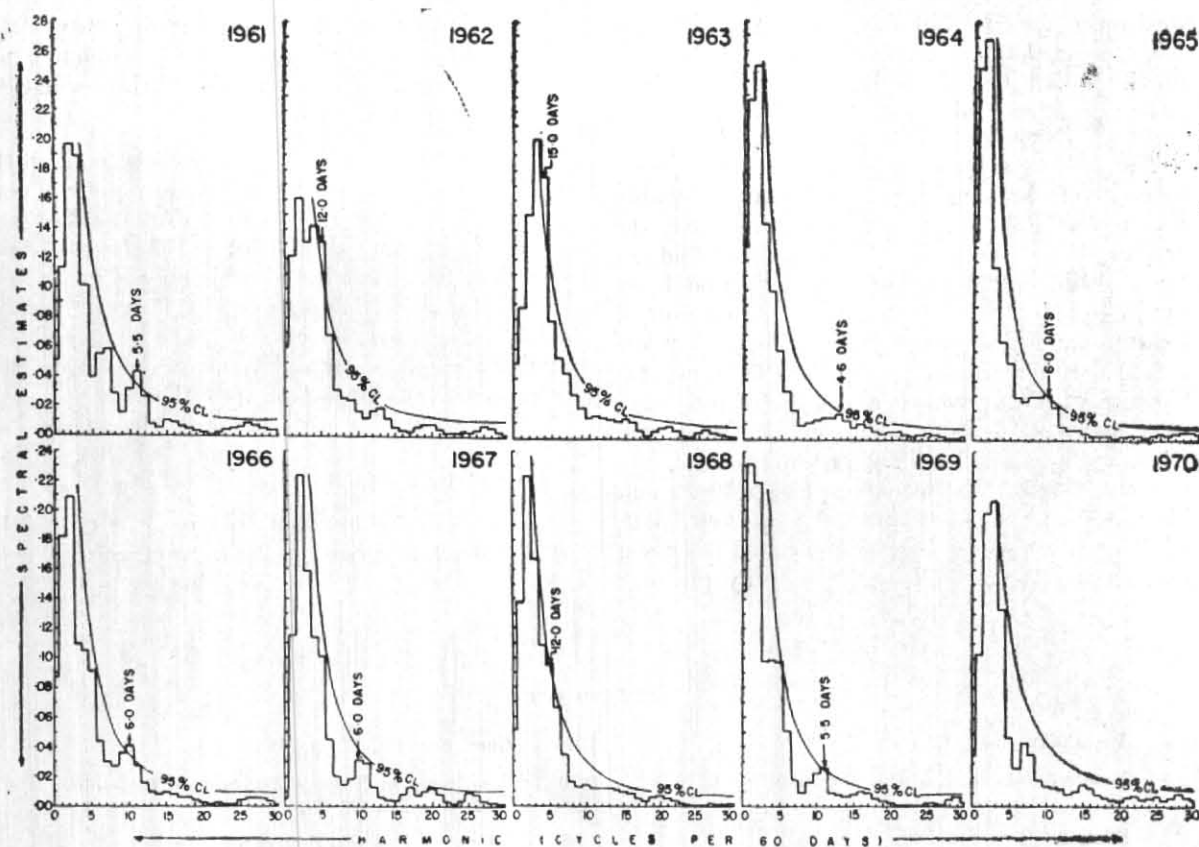


Fig. 2. Power spectra for pressure gradient across Peninsular India

lag of 30 days. The 95 per cent confidence lines corresponding to a red noise spectrum are shown on the diagrams.

3.1. Pressure gradient over north India

The power spectra for the pressure gradients over north India for different years are shown in Fig. 1. The first impression one gets is that considerable power is concentrated in relatively longer periods but these periods are not statistically significant. The statistically significant spectral peaks between 5-6 days period range are common to nearly all the years. A measure of the preference for this periodicity may also be obtained by simply adding the number of significant peak at each of the period for all the years. Table 1 shows the count of 95 per cent level significant spectral peaks for different periods.

It can be seen that the highest count is for the 5-day period and a large number of significant peaks are clustered around 5-day period, *i.e.*, between 4.6 and 6.0 days. Thus, this brings out the fact that there is tendency for the spectra

in these ten years to show particular preference for 5-6 days period and seems to be characteristic of the season. There are also other spectral peaks like, 7.5, 8.6 and 10 days periods statistically significant but these are not consistently noticed from year to year.

3.2. Pressure gradient across Peninsular India

The power spectra for the pressure gradient across Peninsular India for different years are shown in Fig. 2. All the years show relatively large power in longer periods and these are not statistically significant as in the case of pressure gradient over north India. It can also be seen that spectral peaks in very small number, *i.e.*, only six are statistically significant. However, four out of these six peaks, which are present in different years, have a period range of 5-6 days.

4. Discussion and Conclusion

The day to day fluctuations in pressure gradients over India during SW monsoon show particular

preference for the 5-6 days period. The 5-6 days periodicity is conspicuously noticed over north India. On the other hand this feature is less prominent over Peninsular India.

The 5-6 days period prominence in the power spectra of pressure gradients may probably be due to the 5-day pressure oscillation over the tropics. It may be useful to cite classical findings here. Eliot (1895) found the short period barometric oscillations with mean period around 5-day over India and neighbourhood. Frolow (1942) reported the existence of widespread stationary oscillations with a period of 5-6 days over the Caribbean and western Indian Ocean from a study of the daily pressure values. In a recent study Wallace and Chang (1969) and Misra (1972) examined the surface pressure data of tropical stations distributed round the globe and have concluded that the 4-5 day pressure

oscillation is westward propagating wave with a zonal wave length equal to the circumference of the earth. The amplitude of the oscillations increases slowly with latitude.

The periodicity of 5-6 days observed in the pressure gradients over India and spectral peak around 5 days period reported by Ananthkrishnan and Keshavamurthy (1970) in the average daily rainfall for central and adjoining parts of the north India for SW monsoon, lead one to believe that this periodicity may be associated with the pulsatory behaviour of SW monsoon. However, the casual relationship between the 5-day pressure oscillation and rainfall needs further study.

Acknowledgements

The authors are thankful to Dr. K.R. Saha and Shri O.N. Dhar for their encouragement and interest during the course of this study.

REFERENCES

- | | | |
|---|------|--|
| Ananthkrishnan, R. | 1970 | <i>Curr. Sci.</i> , 39 , 11, p. 248. |
| Ananthkrishnan, R. and Keshavamurthy, R. N. | 1970 | Proc. Symp. on Tropical Meteorology, Honolulu, Hawaii, P.L III- 4. |
| Eliot, T. | 1895 | <i>India Met. Memoirs.</i> , 6 , 3, p. 89. |
| Frolow, S. | 1942 | <i>Bull. Am. Met. Soc.</i> , 23 p. 239. |
| Misra, B. M. | 1972 | <i>Mon. Weath. Rev.</i> , 100 , 4, p. 313. |
| Wallace, J. M. and Chang, C. P. | 1969 | <i>J. atmos. Sci.</i> , 26 , 5, p. 1010. |
| World Met. Organ. | 1966 | Climatic change, WMO Tech. Note No. 79, pp. 33-75. |