Indian J. Met. Geophys (1972), 23, 2, 181-184

551.554(23)

On the characteristics of pressure wave at mountain stations

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(*Received 5 May 1971*)

ABSTRACT. Mean hourly pressure data from two mountain stations above 2 km, Kodaikanal and Ooty are analysed using Fourier analysis. The 12-hr wave fits into the pattern discovered by other workers in the field. In contrast, the 24-hr wave shows a phase difference of about 180° between Kodaikanal and Ooty. A sort of reversal in the diurnal wave around 2-km level is suspected. Harmonic analyses of temperature data in respect of these hill stations did not reveal any significant differences between them.

1. Introduction

The pressure wave on mountain stations has not been studied thoroughly. Pyle (1959) based on 15 days data examined the pressure wave at Haleakala Mountain, Hawaii and observed a change in phase with elevation. Bartendu (1967) too discovered that the diurnal pressure wave in the mountain had a maximum during the afternoon. Recently Longley (1969) observed that the times of maximum of the 24-hour wave at Sulphur Mountain (Lat. 51°11'N, Long. 115°34'W, elevation 2283 m) mostly occur between 1800 and 2400 hours (Pacific Standard Time) differing very much from the time of maximum of the diurnal wave at the other mountain station Old Glory (Lat. 49°N, Long. 118°W, elevation 2347 m) which is only about 60 m higher in elevation. A sort of reversal in the behaviour of the diurnal pressure wave near about 2 km level is suspected. At about this altitude we have two hill stations, *viz.*, Kodaikanal and Ooty in South India having records of hourly values of pressure. An analysis of these data has, therefore, been taken up to find out the characteristics of pressure waves at these stations.

2. Pressure variations at Kodaikanal and Ooty

A careful Fourier analysis of the pressure data of the two mountain stations in South India, Kodaikanal (Lat. 10° 14'N, Long. 78°28'E, elevation 2343 m) based on the data for 1954-1968, and Ooty (Lat. 11°36'N, Long. 76°24'E, elevation 2207 m) based on the data for 1965-1967 (data available only for these three years) is done, and the results are presented.

In Fig. 1 the mean hourly pressure values month by month of both the stations are given. It can be easily seen from the mean curves that at Kodaikanal the night maximum pressure is lower than the day maximum and at Ooty the night maximum is higher than the day maximum. This feature is peculiar with respect to Ooty alone in contrast with Kodaikanal as well as other low-level stations. Again the night minimum in most of the months at Kodaikanal is lower than the day minimum, contrary to what is observed at Ooty.

The amplitude and times of maximum of the 24 and 12-hour wave for Kodaikanal and Ooty are presented in Table 1. The behaviour of the 12-hour wave at both the places is uniform as can be seen from Fig. 2.

The irregularity of the 24-hour wave at Kodaikanal and Ooty is very striking. The amplitude and the time of maximum of the 24-hour wave is shown in Fig. 3. The annual, mean value of amplitude at Kodaikanal (0·29 mb) is just half the value of that of Ooty (0·60 mb). The annual mean value of the time of maximum of the 24-hour wave at Kodaikanal occurs at 12·5 hours IST and at Ooty at 0·8 hours IST, exhibiting a difference of about 12 hours. Longley (1969) too found such difference in the occurrence of the time of maximum of the 24-hour wave between Sulphur Mountain and Old Glory. The maximum and minimum amplitude occur in February and October at Kodaikanal whereas they occur in October and March at Ooty.

The variations in the 24-hour wave in mountain area is mainly the effect of orography and topography. In order to ascertain the effect of temperature on the pressure curve, the temperature data for Ooty and Kodaikanal for the period 1965-67 was subjected to Fourier analysis and the amplitudes and times of maximum of the 24 and 12-hour waves of the temperature are given in Table 2. It is evident from the table that the behaviour of the temperature waves at both the stations is similar. It is, therefore, clear that the effect of orography and topography are perhaps the main contributing factors.

TABLE 1

	Kodaikanal				Ooty			
	24-hr wave		12-hr wave		24-hr wave		12-hr wave	
	Amplitude (mb)	Time of max. hrs (IST)	Amplitude (mb)	Time of max. hrs (IST)	Amplitude (mb)	Time of max. hrs (IST)	Amplitude (mb)	Time of max. hrs (IST)
Jan	0·34	13·6	0·98	10·6	0·53	0·0	0·92	10·7
Feb	0·45	14·1	0·95	11·0	0·46	0·3	0·96	11·0
Mar	0·44	14·2	1·02	11·0	0·42	0·4	1·19	11·1
Apr	0·38	13·4	0·96	10·9	0·51	2·7	0·92	11·0
May	0·40	12·7	0·88	10·9	0·57	1·1	0·83	10·9
Jun	0·21	12·2	0·71	10·9	0·66	0·6	0·75	11·0
Jul	0·22	12·8	0·72	11·0	0·51	0·1	0·77	10·8
Aug	0·23	11·9	0·78	10·7	0·69	1·2	0·77	11·0
Sep	0·27	10·5	0·89	10·4	0·72	1·1	0·91	10·6
Oct	0·17	10·1	0·96	10·4	0·74	1·0	0·92	10·5
Nov	0·18	12·3	0·96	10·4	0·70	0·4	1·02	10·4
Dec	0·23	11·6	0·79	10·5	0·67	1·0	0·96	10·5
Annual (mean)	0·29	12·5	0·88	10·7	0·60	0·8	0·91	10·8

TABLE 2

	Kodaikanal				Ooty			
	24-hr wave		12-hr wave		24-hr wave		12-hr wave	
	Amplitude (°C)	Time of max. hrs (IST)	Amplitude (°C)	Time of max. hrs (IST)	Amplitude (°C)	Time of max. hrs (IST)	Amplitude (°C)	Time of max. hrs (IST)
Jan	3·37	13·7	1·21	12·9	4·49	14·2	1·64	12·7
Feb	3·40	13·9	1·58	11·7	4·76	14·3	2·35	11·8
Mar	3·25	14·0	1·23	12·0	4·42	14·3	1·12	12·8
Apr	3·00	13·9	0·98	12·6	3·63	14·3	1·11	12·3
May	2·56	13·3	0·97	12·4	3·21	13·9	0·99	12·2
Jun	2·08	13·4	0·69	12·6	2·07	13·7	0·60	12·4
Jul	1·52	13·6	0·54	12·7	1·38	13·8	0·50	12·9
Aug	1·70	13·6	0·74	12·6	1·92	14·3	0·73	12·9
Sep	1·80	13·6	0·71	12·7	2·17	14·2	0·78	12·5
Oct	1·77	13·7	0·69	12·7	2·56	14·1	0·89	12·5
Nov	1·47	14·3	0·52	12·5	2·64	14·2	0·85	12·5
Dec	2·08	13·9	0·72	12·9	2·72	13·9	0·97	12·8
Annual (mean)	2·33	13·7	0·88	12·5	3·00	14·1	1·00	12·5

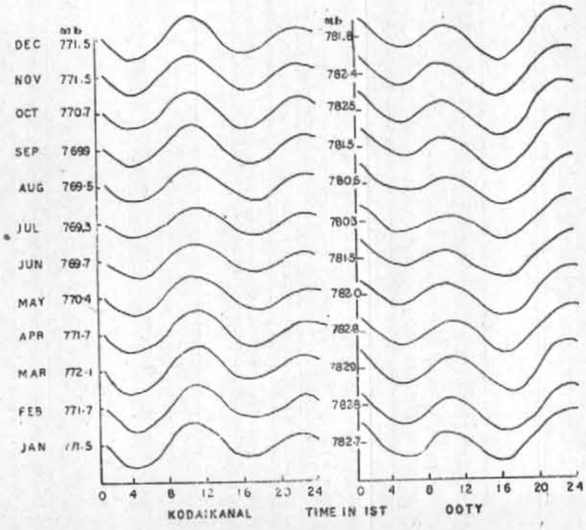

Fig. 1

Mean pressure curves of Kodaikanal and Ooty

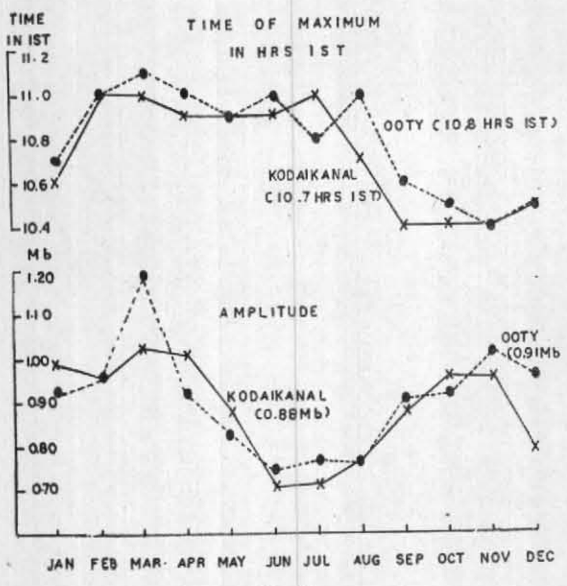

Fig. 2

Seasonal variation of semi-diurnal wave at Ooty and Kodaikanal

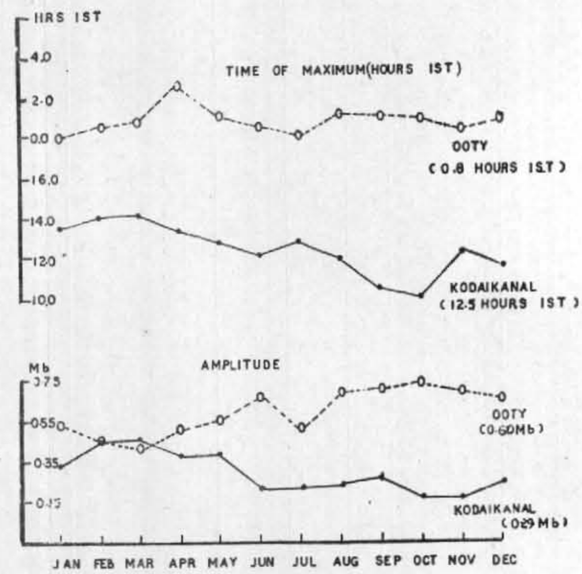

Fig. 3

Seasonal variation of 24-hr wave at Ooty and Kodaikanal

3. Conclusions

Chapman (1951) considered the variability of the 24-hour component to be closely linked to the local temperature cycle and highly sensitive to local influences. Longley (1969) says "The in complete data from Old Glory suggests that there is a reversal of the wave at this height a result that Pyle (1959) and Bartendu *et al.* (1967) both found. These interpreted the wave changes as a result of the vertical currents through solar heating which carried air above 2000 m height".

In the present investigation the mountain stations considered by us are fortuitously around the height of 2·2 and 2·3 kms similar to the two mountain stations considered by Longley (1969). In view of the above findings, we also suspect a sort of reversal in the diurnal wave around 2-km level although topographic and orographic influences appear to be the main contributing factors. Some more investigations of the behaviour of pressure waves over mountain stations may resolve the problem of reversal.

Acknowledgement — The authors wish to acknowledge their grateful thanks to Shri N. M. Philip, Director, Regional Meteorological Centre, Madras for kindly suggesting the problem and for his keen interest showed in completing the study. Our thanks are also due to Professor R. W. Longley, Division of Meteorology, University of Alberta, Edmonton, Canada, for kindly going through the manuscript.

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