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On pressure variations over mountain stations

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ABSTRACT. Pressure data of mountain stations of Srinagar, Leh, Simla, Gangtok and Kathmandu have been analysed using fourier analysis. The 12-hr wave fits into the pattern found by other workers in this field. The amplitude of the 24-hr component at Leh is always higher than the 12-hr component during most part of the year whereas the amplitude of the 24-hr component at Srinagar is higher than that of the 12-hr component during the period May to October. The seasonal variation of the 24-hr wave at Srinagar and Leh are strikingly similar.

1. Introduction

The behaviour of pressure wave over mountain stations has attracted the attention of not only Meteorologists but also geographers. Recently Longley (1969) analysed the pressure data of two mountain stations, Sulphur Mountain and Old Glory at Canada and observed that the times of maximum of the 24-hr wave at Sulphur Mountain (Lat. 51°11′N, Long. 115°34′W, elevation 2283 m) mostly occur between 1800 and 2400 hrs (Pacific standard time) differing very much from the time of maximum of the 24-hr wave at the other mountain station Old Glory (Lat. 49°N, Long. 118°W, elevation 2347 m). Again Narayana and Lakshminarayanan (1973) have analysed the pressure data of two mountain stations Ooty and Kodaikanal in India and observed that the 24-hr components of the pressure waves of Kodaikanal and Ooty have a phase difference of about 180° and suspected a sort of reversal around 2-km level in the diurnal pressure wave. In this note, available pressure data of certain mountain stations in the Himalayan region are analysed and the results discussed.

2. Data

From the *India Weather Review*, Part I, the mean hourly pressure values for the stations, Srinagar (Lat. 34°05′N, Long. 74°5′E, elevation 1587 m) Gangtok (Lat. 27°15′N, Long. 88°35′E, elevation 1812 m) and Kathmandu (Lat. 27°40′N, Long. 85°05′E, elevation 1324 m) were collected for the period 1956-60. Blanford (1878, 1879) in *India Meteorological Department Memoirs*, discussed the hourly variations of pressure over Simla (Lat. 31°15′N, Long. 77°10′E, elevation 2202 m) and Leh (Lat. 34°10′N, Long. 77°30′E, elevation 3450 m) based on 4 observations per month for a period of four years. The hourly pressure values given in the above *Memoirs* for Simla and Leh are used for this study.

The data for the five hill stations have been harmonically analysed and the first, second and the third components of amplitude and times of maximum are presented in Table 1.

3. Pressure variations over mountain stations

Blanford (1878, 1879) pointed out that in Simla "except in July and August, the curves exhibit uniformly the peculiarity which was pointed by Plantamour in the case of the great St. Bernard, that the early morning minimum is the absolute minimum of the day". He also pointed out that the curves of Leh exhibit "the remarkable feature that owing to the great magnitude of the diurnal fall of pressure between the forenoon and the afternoon, during six months of the year (from June to November) the oscillation is single, having but one maximum and one minimum" The curves of Srinagar, Gangtok and Kathmandu exhibit the usual feature of two maxima and two minima, the maxima occurring around 1000 IST in the morning and 2200 IST in the night and two minima occurring around 0400 IST in the early morning and 1600 IST in the afternoon. However, the curves of Kathmandu and Gangtok show that the absolute maximum occurs at night during the month of July in the case of Kathmandu and during the month of August in the case of Gangtok. The data is based only on a five-year period and the same feature may perhaps be noticed even if data for longer periods are used.

4. Semi-diurnal variation of pressure

The monthly values of the semi-diurnal variation of pressure over the five hill stations are shown in

TABLE 1

	24-hr wave		12-hr wave		8-hr wave			24-hr wave		12-hr wave		8-hr wave	
	Amplitude (mb)	Time of maximum (IST)	Amplitude (mb)	Time of maximum (IST)	Amplitude (mb)	Time of maximum (IST)		Amplitude (mb)	Time of maximum (IST)	Amplitude (mb)	Time of maximum (IST)	Amplitude (mb)	Time of maximum (IST)
	Leh							**Simla**					
Jan	0·52	5·7	0·65	9·4	0·12	1·9	Jan	0·62	12·0	1·43	10·5	0·24	2·2
Feb	1·11	6·0	0·67	9·8	0·05	3·0	Feb	0·67	12·3	1·47	10·6	0·16	2·4
Mar	0·89	6·4	0·56	10·3	0·13	1·3	Mar	0·68	12·9	1·48	10·5	0·10	2·4
Apr	0·93	5·5	0·62	10·0	0·03	3·3	Apr	0·79	12·3	1·52	10·5	—	—
May	1·23	5·2	0·74	9·8	0·03	4·2	May	0·97	11·6	1·39	10·5	0·04	5·4
Jun	1·31	6·0	0·57	10·0	0·06	6·3	Jun	0·81	11·5	1·34	10·6	0·04	6·8
Jul	1·60	5·9	0·60	9·7	0·11	1·3	Jul	0·59	9·8	1·36	10·5	0·04	7·2
Aug	1·43	5·3	0·79	10·0	0·02	2·6	Aug	0·57	9·8	1·43	10·4	0·05	6·9
Sep	1·59	6·1	0·70	9·5	0·07	2·9	Sep	0·77	11·2	1·38	10·4	0·13	3·2
Oct	1·33	6·1	0·67	10·1	0·09	2·5	Oct	0·65	11·6	1·45	10·2	0·15	2·6
Nov	1·08	6·5	0·64	9·5	0·09	1·9	Nov	0·63	11·3	1·45	10·2	0·19	2·0
Dec	1·03	7·3	0·67	9·5	0·15	1·9	Dec	0·65	11·8	1·50	10·3	0·21	2·3
Mean	1·17	6·0	0·66	9·8	0·08	2·8	Mean	0·70	11·5	1·43	10·4	0·11	3·9
	Srinagar							**Gangtok**					
Jan	0·47	10·1	0·73	10·6	0·21	3·1	Jan	0·55	7·5	1·02	10·3	0·30	2·2
Feb	0·66	9·6	0·82	10·8	0·19	2·8	Feb	0·50	7·7	1·04	10·3	0·25	2·2
Mar	0·54	9·7	0·79	10·8	0·04	1·7	Mar	0·58	7·5	1·08	10·3	0·17	2·4
Apr	0·68	8·5	0·80	10·8	0·04	7·5	Apr	0·69	7·7	1·08	10·3	0·05	2·9
May	0·74	8·6	0·65	10·7	0·02	2·2	May	0·78	7·5	0·94	10·3	0·02	4·5
Jun	0·82	8·4	0·53	10·3	0·11	6·3	Jun	0·55	7·0	0·79	10·5	0·08	6·1
Jul	0·94	7·9	0·55	11·3	0·11	7·1	Jul	0·47	5·7	0·75	10·5	0·02	5·2
Aug	0·78	8·1	0·63	10·5	0·25	3·1	Aug	0·49	5·2	0·82	10·5	0·08	5·7
Sep	0·96	7·9	0·85	10·4	0·02	6·5	Sep	0·54	6·4	0·98	10·2	0·07	3·0
Oct	0·87	7·7	0·82	10·3	0·10	2·4	Oct	0·55	6·7	1·02	9·9	0·16	2·1
Nov	0·79	8·7	0·85	10·6	0·15	2·2	Nov	0·54	7·3	1·02	9·8	0·25	1·9
Dec	0·53	9·5	0·79	10·6	0·18	2·6	Dec	0·61	7·1	1·01	10·0	0·29	2·2
Mean	0·73	8·7	0·74	10·6	0·12	4·0	Mean	0·57	6·9	0·96	10·2	0·14	3·4
	Kathmandu												
Jan	0·42	7·7	0·83	9·7	0·17	1·7	Jul	0·43	3·2	0·73	10·1	0·02	6·2
Feb	0·41	6·0	0·86	9·8	0·15	1·9	Aug	0·53	4·3	0·86	10·1	0·02	2·0
Mar	0·53	6·5	0·87	9·9	0·10	2·0	Sep	0·47	5·3	0·88	10·1	0·06	4·0
Apr	0·45	6·8	0·82	9·8	0·02	6·1	Oct	0·46	5·6	0·81	10·5	0·08	2·1
May	0·48	6·7	0·74	9·7	0·05	6·2	Nov	0·48	6·1	0·81	10·5	0·13	1·5
Jun	0·54	5·5	0·74	10·2	0·06	5·8	Dec	0·46	6·5	0·79	10·4	0·20	1·8
							Mean	0·47	5·9	0·83	10·1	0·09	1·7

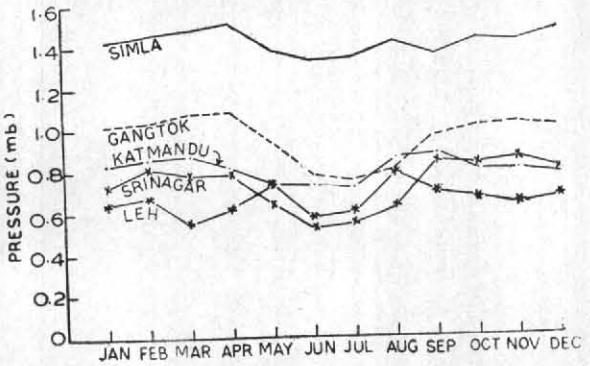

Fig. 1

Seasonal variation of semi-diurnal wave

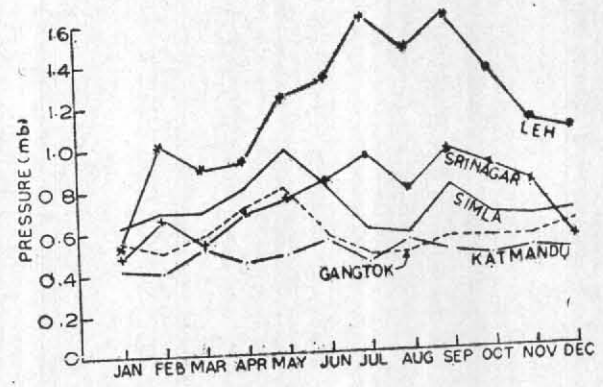

Fig. 2

Seasonal variation of diurnal wave

Fig. 1. The lowest amplitude of the 12-hr wave in all these stations occurs in the months of June-July fitting into the pattern described by other workers. The time of maximum occurs around 1000 IST in all these stations.

5. Diurnal variation of pressure

The monthly values of the 24-hr wave is shown in Fig. 2. This exhibits certain striking features. The variation of the 24-hr component of Leh and Srinagar are strikingly similar. In Leh the amplitude of the 24-hr component is always higher than that of the 12-hr component throughout the year except in the month of January. It has been observed that the atmosphere of Leh, although exceedingly dry, is remarkably clean and transparent and the solar heat most intense" (Blanford 1879). As pointed out earlier during six months of the year (June to November) in Leh the pressure oscillation is single, having but one maximum and minimum. However during the other six months the second maximum and minimum are just perceptible without much significance. The combined effect of the intense solar heat and the single pressure oscillation is perhaps responsible for the amplitude of the 24-hr component being always higher than the 12-hr component at Leh. At Srinagar the 24-hr component amplitudes during the months of May to October are higher than the corresponding amplitudes of the 12-hr component. This is perhaps because of the intense solar heat Srinagar experiences during these months. Chapman (1951) considered the variability of the 24-hr component to be closely linked to the local temperature cycle and highly sensitive to local influences.

The time of maximum of the 24-hr component of the pressure wave at Kathmandu, Leh and Gangtok occurs around 6 hrs IST as in any plain station (Jagannathan and Alvi 1961). The time of occurrence of maximum of the 24-hr component at Simla is 11·5 hrs IST conforming to the occurrence of afternoon maximum of the 24-hr component in the hill stations. The time of maximum of the 24-hr component at Srinagar is around 9·0 hrs IST neither conforming to the pattern of the occurrence

of maximum in the early morning hours as in the case of plain stations nor to the general pattern of the afternoon maximum in the hill stations. The annual mean amplitude at Srinagar of diurnal and semi-diurnal components are more or less equal.

6. Eight-hourly variation of pressure

The eight-hourly wave has significant amplitudes during the winter months November to March in all these hill stations. There is a sudden change of phase angles during the summer months of April-July, the time of maximum occurring about 3 to 4 hrs later than all other months.

7. Conclusion

The 12-hr wave fits in with the observations of others. The seasonal variation of the 24-hr wave at Srinagar and Leh is strikingly similar. The 24-hr wave is irregular and is a combination of thermal and topographical features.

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