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Mountain Lee Waves over Western Ghats

M. C. SINHA

Meteorological Office, Poona

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ABSTRACT. Clouds associated with the short mountain lee waves were observed at Matheran in the Western Ghats on 6 March 1965. In this paper details of the observed lee waves are given. The environmental profile of wind and temperature on this day have also been studied with a view to see whether the conditions were favourable for the formation of the mountain lee waves which were actually observed at Matheran.

1. Introduction

The presence of lee waves over the Western Ghats has not been reported so far. There is generally considerable air traffic over the Western Ghats in the neighbourhood of Bombay and Poona. It is, therefore, of great interest to study the occurrence of the lee waves in this area for safe and efficient air operations. The author has observed lee wave clouds at Matheran on 6 March 1965. The circumstances in which these clouds formed as a consequence of the lee waves are discussed in this paper.

2. Orographic features of Matheran

Matheran (Lat. 18° 59′ N, Long. 73° 18′ E), where these lee wave clouds were observed, is a hill station situated in the Western Ghats on top of a narrow, long and rather isolated northsouth steep ridge. It is about 750 metres high, about 2 km wide and 9 km long at the top. It is situated about 50 km to the east of Bombay. A schematic map of Matheran ridge is shown in Fig. 1.

3. Observations of lee wave clouds

On 6 March 1965, from the morning onwards the sky at Matheran was partly covered with Stratocumulus clouds, generally in very disorganised patches. Towards the afternoon the clouding decreased. But between 1630 IST and about 1825 IST two parallel rows of fine Stratocumulus clouds, oriented north-south, parallel to the ridge with sharply defined edges, typical of the wave clouds, were observed in a northeasterly direction from Porcupine Point, a well known landmark at Matheran. One of the rows of clouds was estimated to be nearly over the northern part of the Matheran ridge and the other row at a distance of about 1 to 2 km to the east of the first row of clouds. The row of clouds over the ridge was very well marked and more prominent than the other row of clouds on the second crest to the east. These clouds had very fine east-west billow structure superimposed over them normal to the crest line. These two rows of clouds were estimated to be at a height of about 1500 metres above sea level or about 750 metres above the ridge. Their thickness was estimated to be about 200 metres approximately. The wavelength inferred from the estimated vertical angles and the height of the clouds was between 1 to 2 km. These rows of clouds remained stationary and unchanged for nearly two hours and were observed all along the way from Paymaster Park to Porcupine Point at Matheran. During this period the sun was shining brightly over the western, windward, bare rocky, steep slope of the northern parts of the Matheran ridge. The thermals must have been present in this region during this period. These wave clouds suddenly weakened and disappeared a few minutes before the sunset. The observations undoubtedly confirm the presence of short mountain lee waves over this region of the Western Ghats, though these waves had only two crests and were not very strong.

4. Discussion of results

In general, the conditions favourable for the formation of the mountain lee waves are given as —

(*a*) Flow where the wind direction does not change with height in a sufficiently deep layer of atmosphere and also which is roughly perpendicular to a sufficiently steep and long ridge,

(*b*) Marked static stability, decreasing with height and the increase of wind with height according to Scorer (1949),

(*c*) A minimum wind speed at the ridge level is not particularly critical, but values around 14 knots appear to be required for small mountains.

The upper air temperature and wind profiles in the corresponding layer of the atmosphere for the nearest upper air observatory at Santacruz, Bombay are given in Fig. 2. The upper winds are found to be blowing steadily from 270 to 250 degrees in the layer from 0·6 to 2·1 km asl, which is nearly perpendicular to the rather steep and long ridge at Matheran. It was also increasing with height from 3 knots at 0·9 km to 17 knots

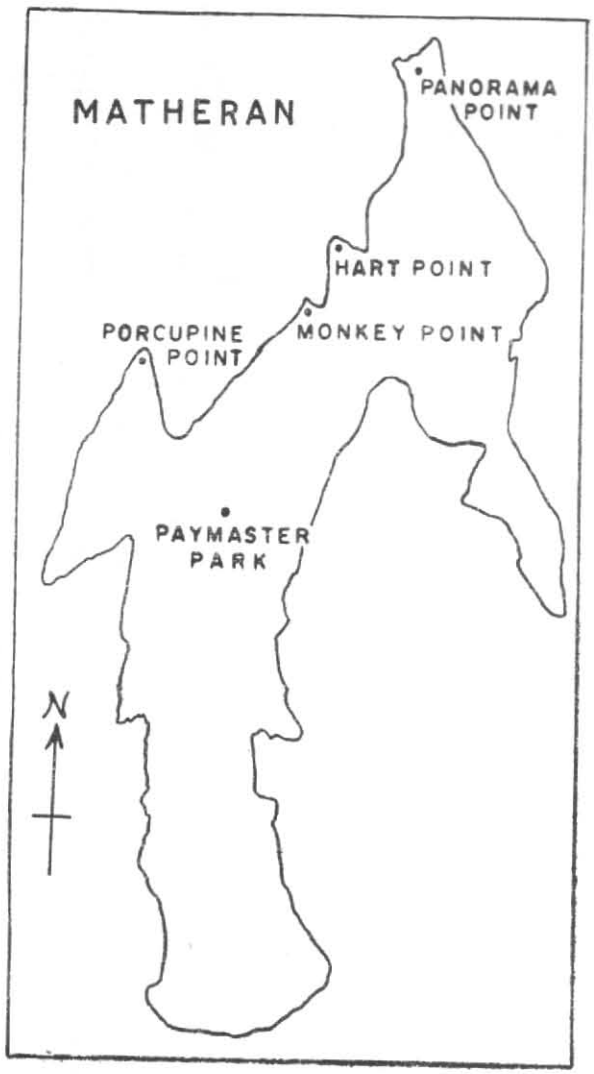

Fig. 1. Schematic map of Matheran

at 2·1 km asl with an average increase of about 12 knots/km. From the environmental temperature profile also it is seen that the atmosphere in general and the layer in question in particular has the required marked static stability. The lapse rate of temperature, from 1 to 1·5 km asl was only about 4° C per km and static stability decreased upwards. All these parameters are suitable for the formation of the mountain lee waves.

As mentioned earlier, the actual height of the ridge is about 750 metres but taking friction into account the effective height may be taken to be say about 1 km. The sun was shining brightly on the bare rocky windward face, and must be producing thermals which will further increase the

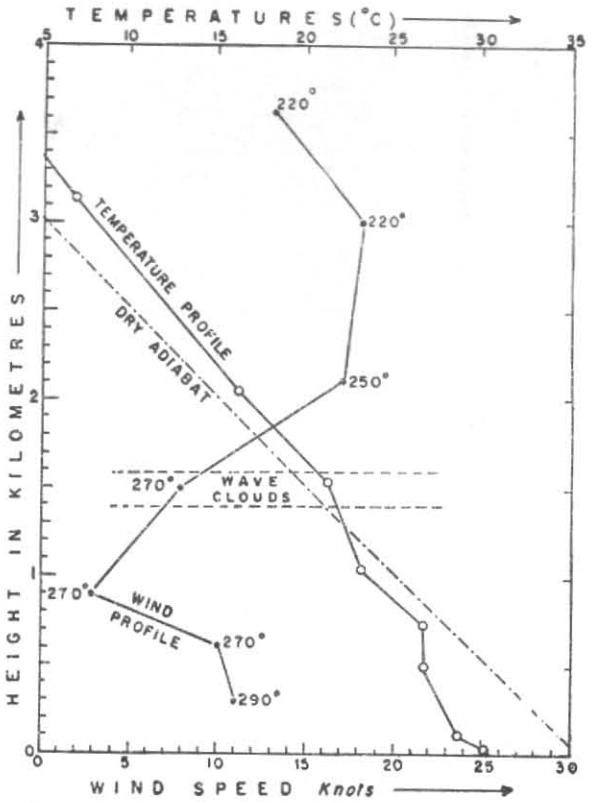

Fig. 2. Wind and temperature profiles at Santacruz, Bombay at 12 GMT on 6 March 1965. Wind directions are also plotted by the side of the wind speed curve

effective height of the Matheran ridge. The wind speed at this level or the level of the lee waves was rather low, but it is probably not so critical. Sinha (1960) has observed and reported the mountain lee waves of wavelengths 1 to 2 km at a height of about 1½ km above ground level with wind speeds of 7 to 10 knots only, within the layer, at Kabul valley in Afghanistan.

The wavelengths of the lee waves decrease with the increase of static stability and the decrease of wind speed in the layer. In this case the marked static stability and the low wind speed in that particular layer were probably responsible for rather short wavelength of these waves. Such short wavelengths are in conformity with the rough theoretical estimates.

All the above considerations conclusively prove that the conditions were favourable on this occasion for the formation of the short mountain lee waves, which were actually observed at Matheran on the evening of 6 March 1965.

REFERENCES

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