

DIURNAL VARIATION OF UPPER AIR TEMPERATURES OVER BOMBAY

Studies on diurnal variation of upper air temperatures have been made by Riehl (1947), Kay (1951), Pant (1960), Dhar and Mitra (1962), Rangarajan and Sikka (1963) and others. The data studied by them were obtained using bimetallic strips as temperature sensors which have large lag and radiation errors. In recent years thermistors are being used as temperature sensors. The radiation and lag errors of thermistors are considerably less as explained below.

The temperature sensor used in the Weather Bureau Radiotheodolite equipment is in the form of a thin rod, and is coated with a white lead

carbonate pigment which gives it an absorption factor for solar radiation of only 6 per cent. The lead carbonate paint coating gives a high reflectivity to most of the wave lengths present in the solar radiation. The thermistor is mounted (without any shield) outside the radiosonde container as an 'out-rigger' frame and at a level higher than the box to ensure good ventilation. Radiation errors, therefore, are relatively small and in use the element is fully exposed.

Even if some zig-zag fluctuation are noticed in the temperature record, which may be due to the effect of solar heating, such effects are eliminated while computing, by connecting the low temperature values by a pencilled line, taking care to avoid eliminating the larger fluctuations that indicate actual variations in the temperature of the air. Thus the radiation errors for the type of element used for temperature in the Weather Bureau Radio-theodolite equipment are almost negligible.

TABLE 1

Median upper air temperatures over Bombay (°C)

Level (mb)	Before onset at time (GMT)				After onset at time (GMT)			
	0000	0600	1200	1800	0000	0600	1200	1800
850	20.8	22.2	22.7	21.0	19.2	20.0	20.0	18.8
700	11.3	13.2	12.3	11.4	10.9	11.8	11.5	10.4
500	— 4.1	— 2.1	— 2.5	— 3.6	— 3.9	— 2.5	— 2.3	— 3.7
400	— 13.1	— 11.7	— 12.6	— 13.3	— 13.5	— 11.7	— 11.7	— 13.4
300	— 29.0	— 26.7	— 28.0	— 29.3	— 28.7	— 25.5	— 26.3	— 28.5
250	— 38.7	— 35.7	— 38.3	— 39.4	— 38.1	— 34.9	— 35.8	— 38.5
200	— 50.6	— 47.9	— 50.3	— 51.9	— 50.5	— 47.9	— 48.1	— 50.4
150	— 64.5	— 61.3	— 64.0	— 65.5	— 67.0	— 62.8	— 64.0	— 65.1
100	76.5	— 73.6	— 76.9	— 79.9	— 80.1	— 77.5	— 77.9	— 80.1

Special radiosonde ascents at 0600 and 1800 GMT were made at Bombay from 23 May to 18 June and 26 June to 16 July 1977 as part of the programme for 'Monsoon-77' experiment. These along with the routine 0000 and 1200 GMT ascents for the period have been availed of to study the diurnal variation of upper air temperatures over Bombay. Since the monsoon set in over Bombay on 17 June during that year, part of the period was in pre-monsoon season (prior to 17 June) and the remaining in monsoon season. Hence the variation in both these seasons could be studied making use of the data.

Data was studied for all standard isobaric levels from 850 to 100 mb. The median values of the temperatures were computed for each of these levels for the pre-monsoon and monsoon days separately for each hour of observation. The use of the median eliminates the error that can be caused by the inclusion of spurious extreme values. The median values are given in Table 1.

The study reveals the following features:

(i) *Absolute value of temperature* — With the onset of the monsoon the temperature values fell by about 2 deg. C in the lower troposphere (850 and 700 mb). They changed little at the mid-tropospheric levels of 500 and 400 mb. They rose by about a degree or so at 300 and 250 mb and fell at higher levels particularly at 0000 and 0600 GMT.

(ii) *Day temperatures* — Mean temperatures at 0600 and 1200 GMT are the same upto about 500 mb before the onset and upto 400 mb after the onset. At higher levels the atmosphere is warmer at 0600 GMT both during before and after the onset. Before the onset the difference between 0600 and 1200 GMT temperatures increases from about 1 deg. C at 400 mb to about 3 deg. C at 100 mb. After the onset the difference is about 1 deg. C from 300 to 100 mb.

(iii) *Night temperatures* — Generally there is very little difference between 1800 and 0000 GMT temperatures below 250 mb before the onset and at all levels after the onset. However, before the onset 0000 GMT temperatures at and above 250 mb are higher by about 1 deg. C than the corresponding values at 1800 GMT.

(iv) *Diurnal range of temperature* — The range of temperature increases from about 2 deg. C in the lower troposphere to about 4 to 5 deg. C at the upper troposphere before the onset of monsoon. After the onset the range becomes smaller being about 1.5 deg. C at and below 500 mb and about 3 deg. C at higher levels. Increase in cloudiness is possibly the cause for the reduction in the range of temperature after the onset of monsoon.

The author wishes to thank Dr. A. K. Mukherjee, Director, Regional Meteorological Centre, Bombay for encouraging the study. Thanks are also due to Shri A. Thiruvengadathan, Meteorologist-in-charge for valuable suggestions and helpful discussions.

References

- Dhar, N. C. and Mitra, H., 1962, *Meteorology in relation to high level aviation over India and surrounding areas*, p. 93, India met. Dep., New Delhi.
- India met. Dep., 1977, *Radiosonde Observations Manual*, II, pp. 6-34, 6-40, 6-96, Instruments Division, New Delhi.
- Kay, R. H., 1951, *Quart. J. R. met. Soc.*, **77**, p. 427.
- Met. Office, London, 1961, *Handbook of Meteorological Instruments*, Part II, p. 137, Her Majesty's Stationery Office, London.
- Pant, P. S., 1960, *Indian J. Met. Geophys.*, **11**, p. 371.
- Rangarajan, S. and Sikka, D. R., 1963, *Indian J. Met. Geophys.*, **14**, p. 261.
- Riehl, H., 1947, *Bull. Am. Met. Soc.*, **28**, p. 311.
-