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The effects of urbanisation and industrial development on air temperatures at Bombay airport

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ABSTRACT. Trend in the minimum and maximum temperatures at Bombay airport has been examined for the period 1950-1974. Colaba temperatures have been taken for comparison.

The study reveals that the mean daily minimum temperature at Bombay airport increased due to rapid urbanisation and industrialisation around the airport. The decreasing trend in mean minimum temperature during 1959 to 1963 was due to the increased air flow from E/NE direction as a result of cutting of hills, in the vicinity of the airport in these directions.

The mean daily maximum temperature also shows an increasing trend from 1962 onwards, due to higher order influence of urbanisation as compared to that of industrialisation.

1. Introduction

The urban climatology and the air pollution climatology are interlinked with each other. The urbanisation and its associated industrial development (air pollution) causes marked changes in the physical properties of the lower layers. Urbanisation and industrial development, change the thermal characteristics of an area by various processes such as, large scale combustion, re-radiation from the urban structures of large thermal capacity, reduced airflow resulting in reduced diffusion of heat and finally re-radiation from air pollutants.

Urban climatic changes in respect of daily mean maximum and minimum, were studied by Arakawa, for fast developing cities like Tokyo and Osaka. Lawrence (1968) studied the effect of urbanisation and air pollution on air temperatures at Manchester (Ringway airport).

In the present study, an attempt has been made to investigate the effects of urbanisation and industrial development on the mean minimum and maximum temperatures at Bombay airport. It may be noted that in post independence era, rapid urbanisation and industrialisation has taken place around Bombay airport, particularly, in the suburbs of Andheri, Kurla and Chembur which are situated in the northeast and southeast sectors of the airport.

2. Data used

Mean monthly minimum and maximum temperatures of Santacruz Observatory for the years 1950 to 1974 have been taken from the *Monthly Meteorological Registers* and for comparison purposes the temperatures recorded at Colaba Observatory have also been used. The Colaba Observatory, situated near the sea shore in the residential area away from the industrial zone, is having limited scope for urbanisation. The data for industrial growth for Greater Bombay in respect of small and large scale industries have been obtained for the years 1952 to 1972 and 1961 to 1972 respectively, from the Director of Industries, Maharashtra State.

Since the hills which were cut-off were situated in the NE/E directions, the frequency of winds from NE/E direction at 03 GMT have been considered, to see the effect of airflow on the minimum temperature. This was taken for the representative month of January for the period 1956 to 1964.

3. Analysis of data and discussion

The fluctuations in the mean minimum and maximum temperatures at Santacruz may be attributed to various effects like, synoptic, topography, industrialisation and urbanisation etc. The synoptic effects have been eliminated by taking differences of Santacruz and Colaba temperatures on the assumption that synoptic effects over Colaba and Santacruz are of the same order. The topographical effects remain constant. Therefore, variations in the difference curves can be attributed only to the relative increase in urbanisation and industrial development around Santacruz airport.

The five-year running means of annual mean daily minimum and maximum temperatures of

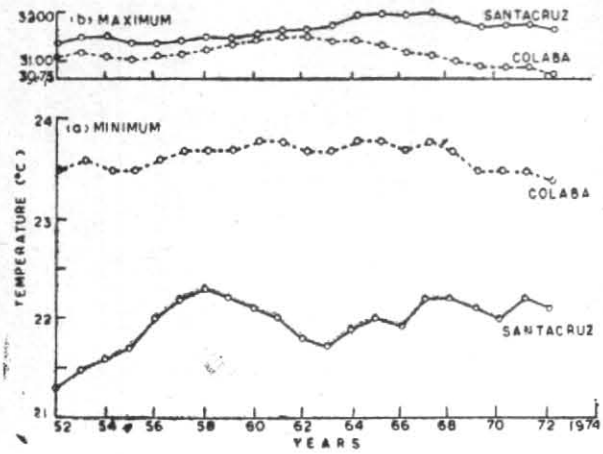

Fig. 1. Five-year running means of annual mean maximum/ minimum temperatures of Colaba and Santacruz

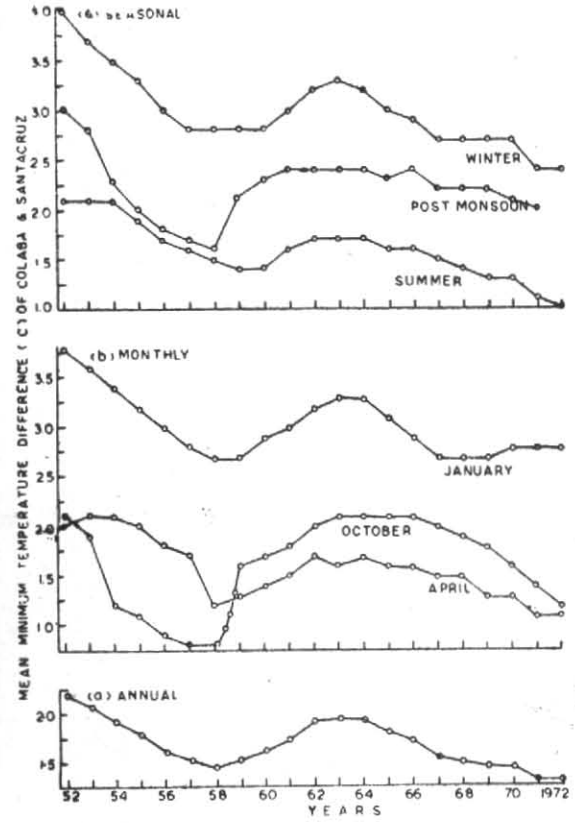

Fig. 2. Five-year running mean of seasonal, monthly and annual mean minimum temperature differences of Colaba and Santacruz

Coaba and Santacruz have been worked out for the period 1950 to 1974 and are presented in Fig. 1. Five-year running means for the annual mean minimum temperature differences for Colaba and Santacruz are presented in Fig. 2(a) and that for representative months of January, April an October and for three seasons (winter, summer and post monsoon) are presented in Figs. 2(b) and 2(c) respectively.

Similar curves for the differences of annual, representative months and seasonal mean maximum temperatures of Colaba and Santacruz have been drawn and are presented in Figs. 3(a) , 3(b) and 3(c) respectively. Monsoon season and its representative month, July, has been omitted from the study because during monsoon the temperatures are mainly influenced due to rainfall and effects of urbanisation and industrialisation are negligible.

4. Mean minimum temperature

It can be seen from Fig. 2 that all the curves show broadly the same trend, hence only annual trend (Fig. 2a) is discussed.

It can be clearly seen that there is deceasing trend till 1958. This shows that the annual mean minimum temperature of Santacruz is increasing. This increase is due to urbanisation and industrial pollution as a result of cumulative growth of large and small scale industries in the suburbs of Bombay (Fig. 5). It is clearly seen that the industrial growth from 1952 to 1964 for Greater Bombay was rapid.

The curve shows an increasing trend from 1958 to 1963, *i. e.*, the mean minimum temperature of Santacruz is decreasing. It may be stated in this connection that to provide proper air navigation facilities some hills around the airport situated in the E/NE direction were cut in two stages, first from 1958 to 1963 and secondly from 1970 to 1972. But the second phase of cutting of hills was of much lesser order. This cutting of hills caused flow of more air from E/NE direction resulting in lowering of minimum temperature. This fact is clearly depicted in Fig. 4, which gives a graph of monthly frequency of wind from E/NE direction for January at 03 GMT for the period 1956 to 1964. The curve shows an increased frequency of E/NE wind after 1958, confirming the effect of cutting of hills on minimum temperature.

From the year 1963 onwards (Fig. 2a) a decreasing trend is seen, *i. e.*, the mean minimum temperature of Santacruz is increasing. However,

the rate of increase during this period is much less than the rate during 1950 to 1958.

The reason is of two fold. First, due to less rapid industrial growth from 1964 onwards as can be seen from Fig. 5, and secondly, due to neutralizing effect of second phase of hill cutting which was of much lesser order.

5. Mean maximum temperature

It can be seen from Fig. 3 that all the curves show almost similar trends and hence the annual mean maximum temperature differences curve is discussed in detail. There is no significant change (Fig. 3 a) from 1952 to 1961. The curve shows an increasing trend from 1962 onwards with a rapid change from 1962 to 1967. The mean maximum temperature of Santacruz shows an increasing trend during this period. Here it may be stated that during the above period there was relatively rapid increase in urbanisation activity around Bombay airport, *i.e.*, extension of runway, construction of highway and residential buildings and new IAC/ Air India hangar complexes, etc causing retention of heat by re-radiation from these urban structures.

Lawrence (1968) has stated that as regards maximum temperature, while artificial heating and retention of heat (urbanisation) may cause an increase, but air pollution may cause a decrease. Thus the combined effect of urbanisation and air pollution (industrial development) on maximum temperature may be either positive or negative depending upon the relative contribution of the two factors. In the present case the increasing trend of mean maximum temperature of Santacruz is due to higher order influence of urbanisation as compared to air pollution effect from 1962 onwards.

6. Conclusion

1. This study brings out the interesting fact that the temperatures at Santacruz are affected due to industrial development and urbanisation which has taken place in suburbs around Bombay airport.

2. The mean daily minimum temperature at Santacruz increased from the year 1950 to 1958 and again from the year 1963 to 1974 due to industrialisation and urbanisation. However, during the period 1958 to 1963, it decreased due to higher order influence of non-urbanisation activity, *i.e.*, cutting of the Kurla hills.

3. The mean daily maximum temperature at Santacruz also showed an increasing trend from 1962 onwards due to the combined effect of industrialisation and urbanisation since the effect of urbanisation was of higher order than that of industrialisation.

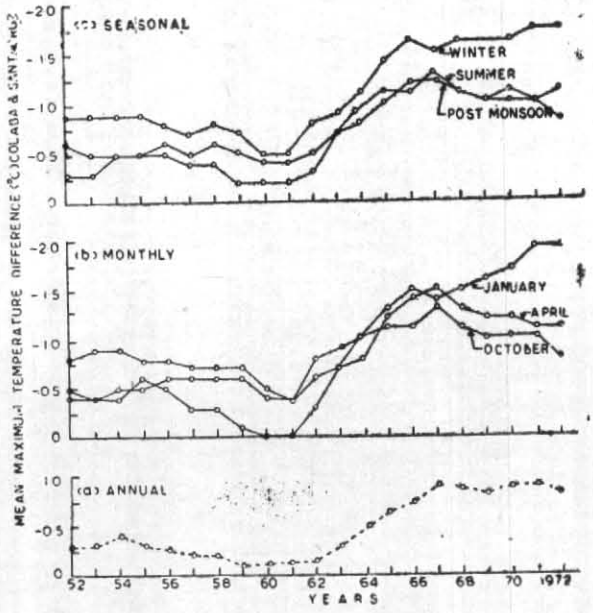

Fig. 3. Five-year running mean of seasonal, monthly and annual maximum temperature differences of Colaba and Santacruz

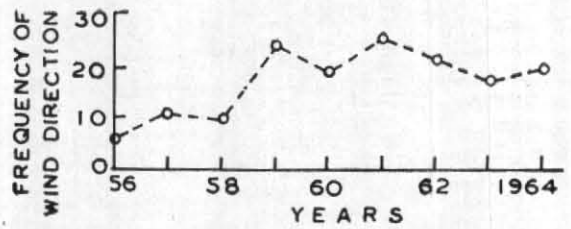

Fig 4. Frequency of wind from E/NE direction for the month of Januar at 0300 GMT

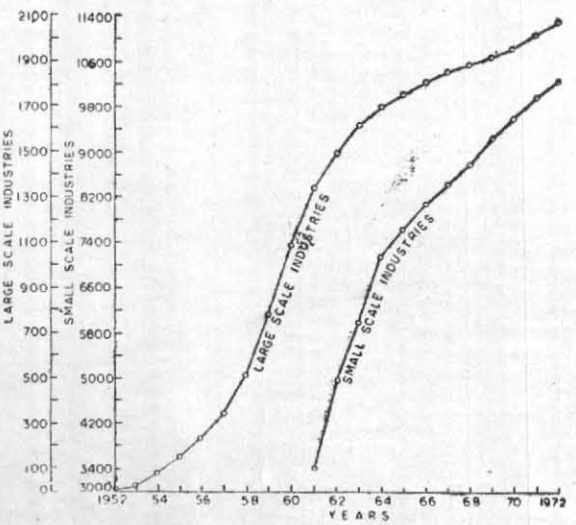

Fig. 5. Cumulative growth of large and small scale industries in Greater Bombay

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