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Significant variations in maximum and minimum temperatures at Bombay airport

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सार — इस शोधपत्र में पांच वर्ष (1972–76) की अवधि में बम्बई हवाई अड्डे पर प्रत्येक चौबीस घंटों में अधिकतम और न्यूनतम तापमानों के महत्वपूर्ण परिवर्तनों और पूर्ववर्ती लगभग आठ से दस घंटों तक की निम्न स्तरीय पवनों के परिवर्तनों के साहचर्य को प्रस्तुत किया गया है।

ABSTRACT. The paper presents the results of a study on the association between the significant 24-hour changes of maximum and minimum temperatures over Bombay Airport and the changes in lower level winds prevailing over the station about 8 to 10 hours earlier during the 5-year period (1972-76).

1. Introduction

In this study the 24-hr changes in the lower level winds over Bombay are co-related with the changes in the maximum/minimum temperatures. It is noticed that the changes of the 18 GMT winds at 0.15 and 0.3 km a.g.l. are closely associated with the minimum temperature recorded the next morning, while the changes of the 00 GMT winds at 0.3 and 0.6 km a. g. l. are related to the maximum temperatures recorded on the same afternoon.

If the 24-hr changes in the lower level winds indicate that the air is coming from warmer region, the temperature can be expected to rise, while if it is coming from a colder region, temperature can be expected to fall.

During day the land (to the east of Bombay) gets heated more than the sea (to its west). Hence an increase in the easterly component or decrease in the westerly component of the wind at 00 GMT would indicate a rise of maximum temperature, while decrease in the easterly component or an increase in the westerly component would suggest a fall in the maximum temperature.

Similarly during night, land (to the east of Bombay) gets cooled much more and earlier than the sea (to its west). Hence an increase in the easterly component or a decrease in the westerly component of the wind at 18 GMT would indicate a fall of minimum temperature, while a decrease in the easterly component or increase in the westerly component would suggest a rise of minimum temperature.

During summer the warmer area lies to the north of Bombay while in winter it lies to its south. Hence an increase of northerly component or decrease of southerly component will lower the temperature and an increase of southerly component and decrease of northerly component will increase the temperature in winter. The reverse will be case in summer. The result holds good both for maximum and minimum temperatures.

Some synoptic systems, like the movement of a trough at lower level, from west to east, can cause these significant temperature variations.

2. Data used

Data for the 5-year period 1972 to 1976 have been used in the analysis. 24-hr changes of maximum/minimum temperatures of magnitude 3° C or more are considered significant.

3. Analysis and discussions

Table 1 gives the number of such occasions separately for rise and fall of maximum and minimum temperatures during the period. It will be noticed that changes of this magnitude are not considered for the monsoon months and are quite few in May. It may be seen that

TABLE 1

Frequency of rise/fall cases in various months for maximum and minimum temperatures during 1972-76

	Rise		Fall		Total	
	Max	Min	Max	Min	Max	Min
Jan	15	03	13	07	28	10
Feb	15	10	12	07	27	17
Mar	13	07	11	02	24	09
Apr	06	01	05	01	11	02
May	01	01	01	01	02	02
Oct	05	03	06	02	11	05
Nov	02	04	04	05	06	09
Dec	05	06	03	04	08	10
Total	62	35	55	29	117	64

large changes of temperature occur more frequently in the case of maximum temperature than for minimum temperature. Large changes of maximum temperature occur more frequently during the period January to March, while such changes in minimum temperature occur more frequently from November to March.

The 24-hr changes in the zonal and meridional components of the lower level winds (18 GMT for minimum temperature and 00 GMT for maximum temperature) have been computed for each of the days, when the change of temperature was more than 3° C.

Table 2 gives the percentage frequency of significant rise/fall of maximum temperature, associated with increase of northerly, southerly, easterly and westerly components of winds, separately for summer and winter seasons between the levels 0.3 and 0.6 km a. m. s. l. Table 3 gives similar information in respect of minimum temperature changes for the layer between 0.15 and 0.3 km a.m.s.l.

Table 2 shows that during both winter and summer, rise of maximum temperature was associated in a large number of cases (91 per cent in winter and 71 per cent in summer) with increase in the easterly component and fall with an increase in the westerly component (67 per cent in winter and 88 per cent in summer). The association with the meridional component was, however, different for the two seasons, while the southerly component (91 per cent) increase with a rise and the northerly component (67 per cent) with a fall of maximum temperature in winter, the northerlies increased with a rise of temperature (86 per cent) and southerlies (75 per cent) with fall in summer.

TABLE 2

Percentage frequency of increase of zonal and meridional wind components of 00 GMT winds between the levels 0.3 and 0.6 km a. m.s. l. for maximum temperature

Period	Max. temp.	Percentage frequency of increase of wind components			
		N	S	E	W
Nov-Feb	Rise	09	91	91	09
	Fall	67	33	33	67
Mar-May & Oct	Rise	86	14	71	29
	Fall	25	75	12	88

TABLE 3

Percentage frequency of increase of zonal and meridional wind components of 18 GMT winds between the levels 0.15 and 0.3 km a.m.s.l. for minimum temperature

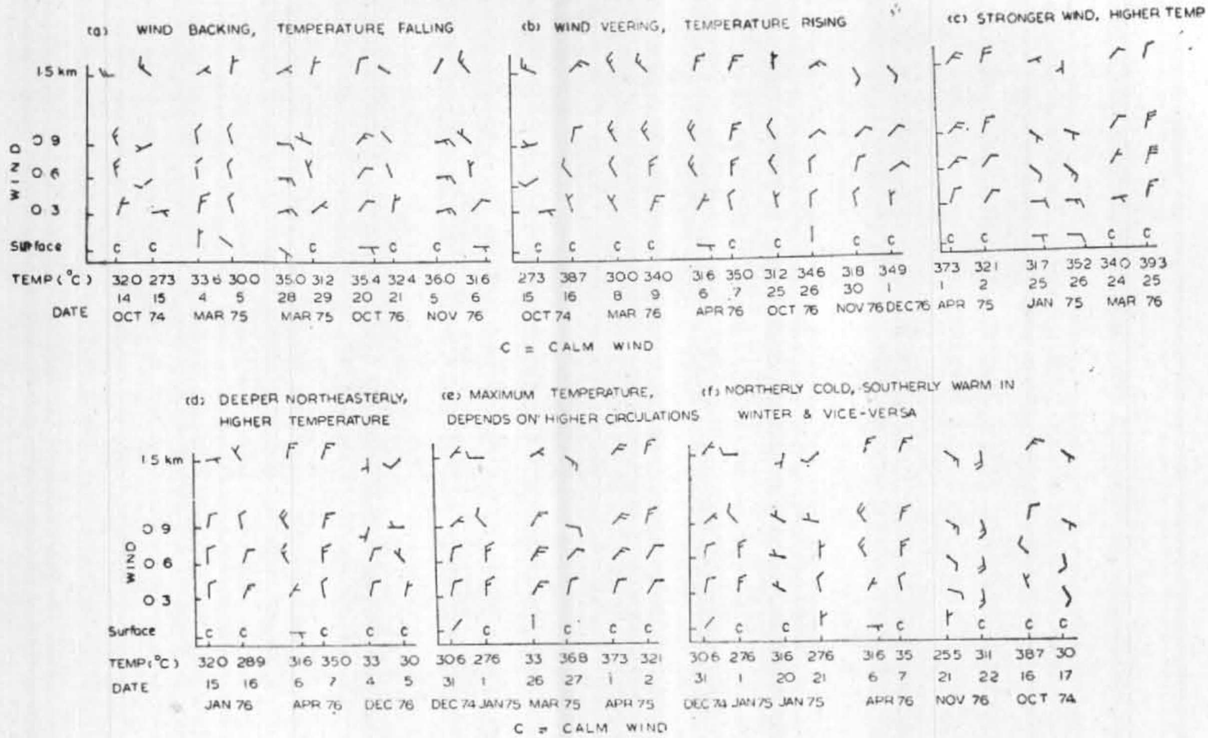
Period	Min. temp.	Percentage frequency of increase of wind components			
		N	S	E	W
Nov-Feb	Rise	22	78	43	57
	Fall	48	52	65	35
Mar-May & Oct	Rise	18	82	27	73
	Fall	40	60	80	20

In Table 3, in the case of minimum temperature, in both the seasons, the rise of temperature was associated with increase in westerly (57 per cent in winter and 73 per cent in summer) and southerly (78 per cent in winter and 82 per cent in summer). When the temperature fell, easterly components increased (in 65 per cent cases in winter and 80 per cent in summer) and the southerly component increased in 60 per cent cases in summer. The association between the fall of minimum temperature and changes in meridional component is poor in winter.

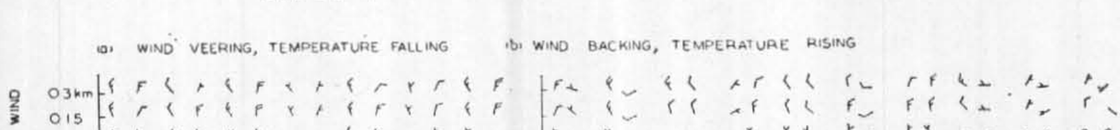
A few cases illustrating the changes in the wind associated with significant ehanges of maximum and minimum temperatures are given in Figs. 1 and 2 respectively. In these diagrams the lower level winds for pairs of consecutive days with significant change of temperature from the first to the second day and the maximum or minimum temperature recorded subsequently are shown.

3.1 *Maximum temperature*

(*i*) *Backing or veering of wind*: In Figs. 1 (a) and (b) illustrate cases where fall of temperature is associated with backing of wind



Figs. 1 (a-f). 00 GMT winds & maximum temperature variations



Figs. 2 (a-d). 18 GMT wind & maximum temperature variations

and rise of temperature with veering of winds respectively. Since the winds are generally northerly during the months under consideration, backing implies increase of westerly component, *i.e.,* wind from the sea which is colder in the afternoon and veering wind from the hot land.

(*ii*) Fig. 1 (c) gives examples of cases where increase of easterly component leads to rise of maximum temperature and decrease to fall.

(*iii*) Fig. 1 (d) shows cases where an increase in the depth of the easterly results in rise of temperature and decrease, fall in temperature.

(*iv*) Sometime wind at 0.3 and 0.6 km a.g.l. has not shown any change of direction from one day to the next. However, if a change of wind direction occurs at higher levels, *i.e.,* at 0.9 and 1.5 km a.g.l. they also cause the maximum temperature to change appreciably. A few cases are illustrated in Fig. 1 (e).

(*v*) Examples of the changes of temperature associated with meridional wind components are shown in Fig. 1 (f). As already mentioned, the meridional components have varying influence on maximum temperature in summer and winter.

3.2. *Minimum temperature*

(*i*) Figs. 2 (a) and (b) illustrate cases of significant changes of minimum temperature associated with backing or veering of wind. Since the winds during the non-monsoon months are northerly, backing of winds implies increase of westerly component or wind from the sea, which is warm during night. Hence backing of wind would be associated with rise of minimum temperature. Veering of wind on same considerations would cause fall of minimum temperature.

(*ii*) In Fig. 2 (c) are given examples of fall/rise of minimum temperature associated with decrease/ increase in wind speed respectively. The increased wind causes turbulent mixing and rise in minimum temperature, while weakening of the wind causes appreciable fall in the minimum temperature.

(*iii*) Effect of the meridional wind component on the changes in minimum temperature can be seen from example given in Fig. 2 (d).

4. Conclusions

Day to day large changes of temperature occur more frequently in the case of maximum temperature than for minimum temperature. In the case of maximum temperature these changes occur more frequently during the period January to March, while such changes in minimum temperature occur more frequently from November to March.

Rise of maximum temperature is associated (in 91 per cent cases in winter and 71 per cent in summer) with increase in the easterly component and fall with an increase in the westerly component (67 per cent in winter and 88 per cent in summer) while the southerly component is associated in 91 per cent cases with a rise and the northerly component in 67 per cent cases with a fall of maximum temperature in winter and the northerly component in 86 per cent cases with a rise of maximum temperature in summer and southerlies in 75 per cent cases with a fall in summer.

In case of minimum temperature in both the seasons the rise of temperature was associated with increase in westerly (in 57 per cent cases in winter and 73 per cent in summer) and increase in southerly (78 per cent in winter and 82 per cent in summer). When the temperature fell, easterly component increased (65 per cent in winter and 80 per cent in summer) and the southerly component increased in 60 per cent cases in summer. The association between the fall of minimum temperature and change in meridional component is poor in winter.

Backing of 00 GMT wind implies colder wind from sea during day and hence fall of maximum temperature and veering implies wind from land and hence rise of maximum temperature.

Increase in depth of the easterly also results in rise of maximum temperature.

In case of minimum temperature backing of 18 GMT wind implies wind from sea, which is warm during night and hence increase in temperature and veering will result in fall.

Increase of wind speed also causes more turbulent mixing and hence rise of minimum temperature, while its weakening brings fall.

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