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A comparative study of Runway Temperature and Screen Temperature observations made at Dum Dum Airport : Reports of a preliminary study

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ABSTRACT. Result of a preliminary study of runway and screen temperature readings recorded at Dum Dum Airport at six synoptic hours (at 0000, 0300, 0600, 0900, 1200 and 1800 GMT) for a period of 21 months (from February 1959 to October 1960) is reported in this short communication. It has been found that the difference of temperature readings is generally less than 1°C except during winter and pre-monsoon seasons for a period from a couple of hours after sunrise to about 0600 GMT. It has also been found that the runway temperature is generally higher than the screen temperature. The reason for the higher values of runway temperature has been attributed to radiation effect.

1. Introduction

An air temperature representative of the average over the runway is of great importance to the aviators. Normally, the temperature recorded in a well sited Stevenson Screen in the observatory enclosure is supplied to aviators. With the advent of jet aircraft operations, it has been recommended by ICAO that the air temperature should be recorded right over the runway of international aerodromes for supplying the temperature data to the aircraft. For this purpose a study was undertaken to establish a statistical relation between the temperature recorded over the runway at Dum Dum aerodrome, and that recorded in a Stevenson Screen in the observatory located 1100 yards to the north-west of the former (*i.e.*, the spot on the runway where temperature observations were recorded). The result of this study is presented in this short communication.

2. Data used

Temperature observations were simultaneously recorded in the Stevenson Screen enclosure at Dum Dum observatory in the usual way and over the runway at Dum Dum aerodrome by a sling psychrometer at six fixed synoptic hours, *i.e.*, 0000, 0300, 0600, 0900, 1200 and 1800 GMT. The observations were commenced from 1 February 1959, and data obtained for 21 months, *i.e.*, up to October 1960, have been analysed.

Unfortunately, it was not possible to record the temperature over the runway at the above fixed synoptic hours on all the days due to technical difficulties. The actual number of occasions when the temperature readings were simultaneously recorded at these two spots are given below—

Jan	51	May	117	Sep	193
Feb	122	Jun	149	Oct	234
Mar	117	Jul	122	Nov	117
Apr	135	Aug	162	Dec	73

It is thus seen that on 1952 occasions simultaneous temperature observations are available for study. The data are presented in Table 1. For the sake of convenience the above data have also been represented graphically in Fig. 1. In the above figure, an asterisk indicates occasions when the number of observations was less than 10.

3. Discussions

It may be seen from Table 1 and also from Fig. 1 that the temperature over the runway at Dum Dum aerodrome is generally higher

TABLE 1

Average difference of Runway temperature (R) and Screen temperature (S) as recorded at Dum Dum airport during the period February 1959 to October 1960

	0000		0300		0600		0900		1200		1800 GMT	
	R–S (°C)	N	R–S (°C)	N	R–S (°C)	N	R–S (°C)	N	R–S (°C)	N	R–S (°C)	N
Jan	—0·9	10	+1·6	11	+1·2*	6	+0·5	8	—0·1	12	—0·5	4
Feb	—0·2	33	+2·5*	4	+1·8*	2	+0·6	27	—1·0	32	—0·4	24
Mar	+0·4	22	+1·1	14	+1·6	12	+0·7	20	—0·3	25	—0·1	24
Apr	+0·8	20	+1·3	20	+1·2	15	+0·8	22	—0·1	31	+0·4	27
May	+0·9	21	+1·4	24	+1·4	12	+1·1	19	—0·1	22	+0·3	19
Jun	+0·8	24	+0·9	27	+0·9	19	+0·7	25	+0·2	31	+0·4	23
Jul	+0·6	24	+0·4	20	+1·0	20	+0·3	19	+0·2	22	+0·3	17
Aug	+0·7	30	+0·8	25	+0·8	25	+0·3	30	+0·1	29	+0·3	23
Sep	+0·3	44	+0·7	29	+0·8	21	+0·4	30	0·0	33	+0·3	36
Oct	+0·6	46	+1·1	44	+0·9	27	+0·5	41	+0·3	40	+0·4	36
Nov	+0·3	22	+1·8	22	+0·7	17	+0·6	15	0·0	21	+0·5	20
Dec	+0·6	11	+2·3	16	+0·2*	9	+0·8	11	—0·7	16	+1·3	10

N represents the number of observations

*indicates the occasions when the number of observations is less than 10

than that of the Stevenson Screen except for 0000 GMT during January and February, 1200 GMT during December to March, and 1800 GMT during January to March. When the runway temperature is higher than the screen temperature, it is seen that the temperature difference is generally less than 1°C except for 0300 GMT during October to May, 0600 GMT during January to May and 1800 GMT during December.

Before analysing the data, it is proposed to consider the physical conditions of the observing spots. The runway is made of concrete structure, whereas the observatory enclosure (where the Stevenson Screen is installed) is a grassy plot of land where there is no cement or concrete structure. It seems also worthwhile to mention that the observatory enclosure has been constructed over marshy land. As such, the observatory enclosure is more humid than the runway.

The results of the study according to observations made at each synoptic hour are presented below. Henceforth the air temperature over the runway will be termed as "runway temperature" and the air temperature recorded in the Stevenson Screen enclosure will be termed as "Screen temperature".

(*a*) *0000 GMT*—It is seen that the difference of temperature readings is generally less than 1°C throughout the entire period of observations. It is also seen that the runway temperature is generally higher than the Screen temperature except during the winter months of January and February, the difference being 0°·9 C and 0°·3 C respectively.

(*b*) *0300 GMT*—The maximum difference between these two sets of temperature observations has been recorded during 0300 GMT. It is seen that the difference is generally less than 1°C between the period June to September. During the remaining months the

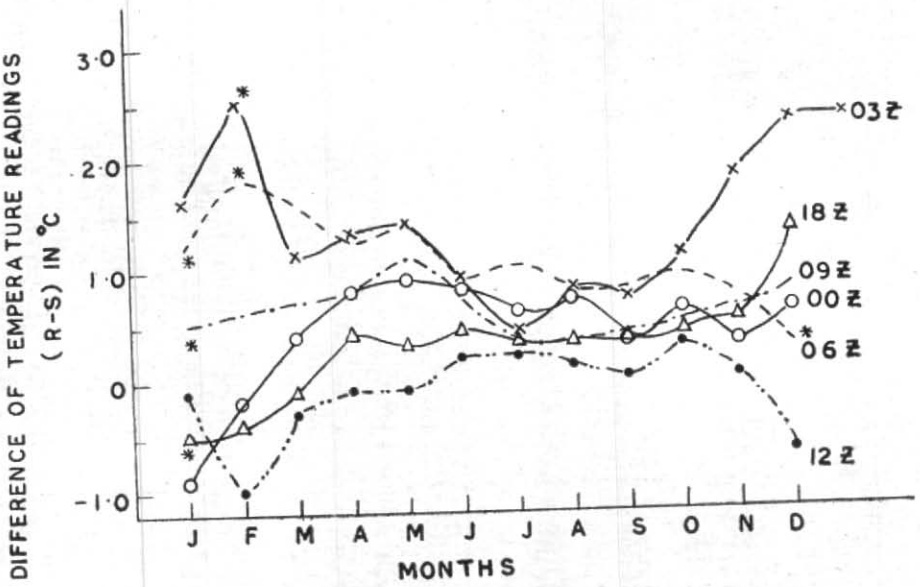

Fig. 1. Curves showing the variation of difference of Runway temperature (R) and Screen temperature (S) against months of the year as recorded at Dum Dum airport during the period Feb 1959 to Oct 1960

*indicates the occasions when the number of observations is less than 10

difference is more than 1°C. The higher value of the temperature over the runway during February could be due to the effect of radiation.

(*c*) *0600 GMT*—The difference of temperature readings is less than 1°C from June to December. During January to May the difference is more than 1°C, the maximum (1°·8 C) being during February.

(*d*) *0900 GMT*—The temperature difference between the entire period is less than 1°C except during May when the difference is 1°.1 C. It is also seen that the runway temperature is higher than the Screen temperature. This is probably due to the radiation effect.

(*e*) *1200 GMT*—Here also the difference of the temperature readings is less than 1°C during the entire period. During December to May, the runway temperature is less than the Screen temperature. Out of these six months, the temperature difference during January, March, April and May is only 0°·3 C or less. During December and February, the difference is 0°·7 and 1°C respectively. The reason for the lower values of runway temperature during the winter months could also be due to radiation effect.

(*f*) *1800 GMT*—The difference of temperature readings is generally less than 1° C except during December when the runway temperature is higher than the Screen temperature by 1°·3 C. It is seen that the runway temperature is generally higher than the Screen temperature.

Next, the available data have been analysed seasonwise to see if any correlation exists between the data in a particular season with the advance of the day. For this purpose, the data have been classified into four predominant seasons, *viz.*, Winter (November—February), Pre-monsoon (March—May), Monsoon (June—August) and Post monsoon (September—October). The data are represented graphically in Fig. 2 in which the broken curves indicate cases when the number of occasions is less than 10. The results are summarised below.

(*a*) *Winter*—It is seen from Fig. 2 (a) that during the winter season, the difference of

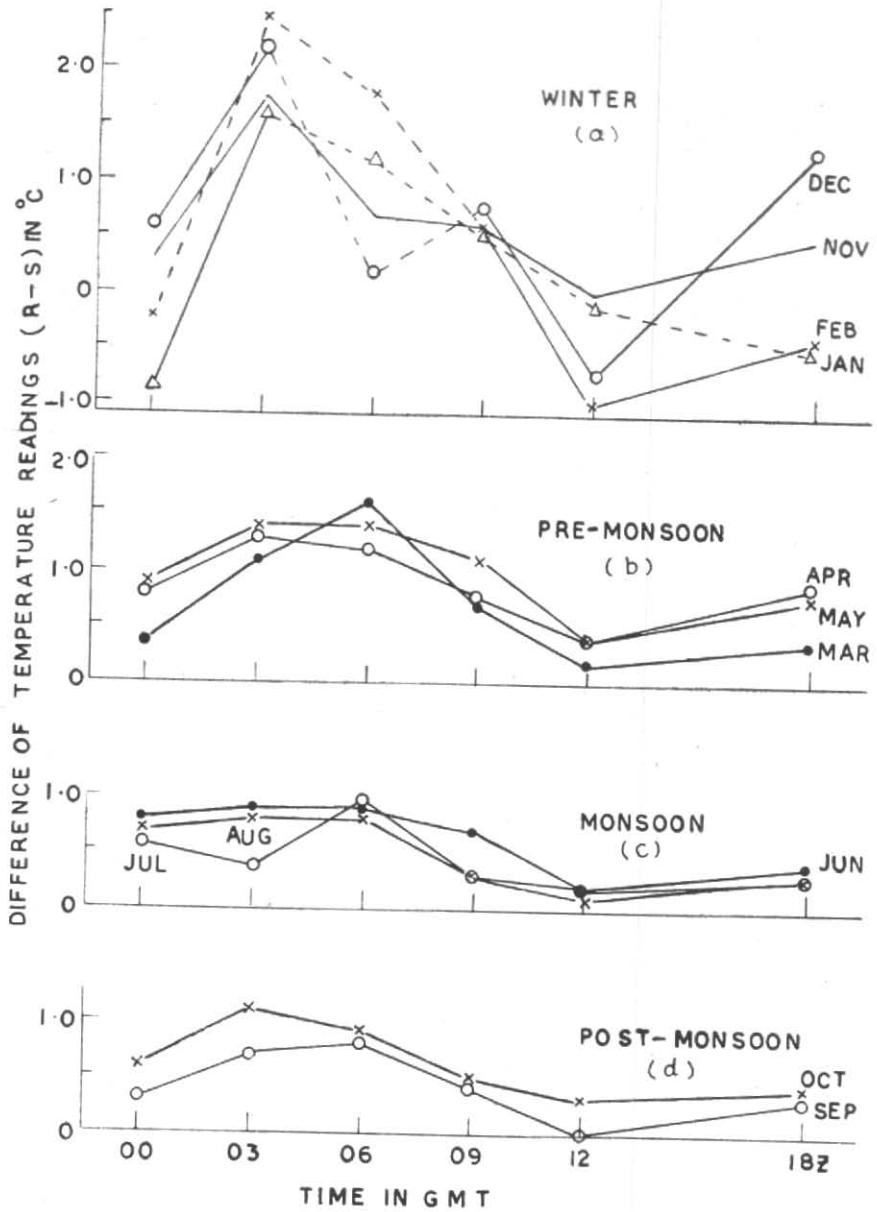

Fig. 2. Curves showing the variation of difference of Runway temperature (R) and Screen temperature (S) against time as recorded at Dum Dum airport during the period Feb 1959 to Oct 1960

Broken lines show the cases when the number of occasions is less than 10

runway and screen temperature readings (runway temperature *minus* screen temperature) increases with the advance of the day upto 0300 GMT (*i.e.*, from 0000 to 0300 GMT). The difference then tends to decrease upto 0900 GMT, runway temperature being higher than the screen temperature. The decrease in the difference continues from 0900 to 1200 GMT. The difference of temperature readings then increases from 1200 to 1800 GMT. From 1800 to 0000 GMT, it is seen that the difference of temperature readings slightly decreases. During the winter season, the sun rises over Calcutta before 0000 GMT and sets before 1200 GMT. It is thus seen that from sunrise (0000 GMT) upto 0900 GMT, the runway temperature is generally higher than the screen temperature, the difference being maximum at 0300 GMT, *i.e.*, about 3 hours after sunrise. Sometime between 0900 and 1200 GMT, the difference is zero, *i.e.*, the runway temperature is equal to the screen temperature. After sunset (*i.e.*, 1200 GMT), the difference increases upto 1800 GMT, the runway temperature readings being higher during October and November and lower during January and February at 1800 GMT. After 1800 GMT again the difference of temperature readings decreases (except during February) up to 0000 GMT.

(*b*) *Pre-monsoon*—During the pre-monsoon season (Fig. 2 b), the runway temperature is generally higher than the screen temperature, the maximum difference being 1°·5 C at 0600 GMT during March. At 1200 GMT, however, the runway temperature is slightly less than the screen temperature. After 1200 GMT, the runway temperature tends to be higher than the screen temperature except during March when the difference tends to be equal to zero.

(*c*) *Monsoon*—During the monsoon season (Fig. 2 c) the runway temperature is higher than the screen temperature, the maximum difference being 1°C at 0000 GMT during July. From 1200 to 1800 GMT, the difference is less than 0°.4C. During the monsoon season the radiation effect is not very prominent. It is, therefore, expected that the value of temperature readings at these two spots should be almost the same. This expectation has come out fairly well.

(*d*) *Post-monsoon*—During the post monsoon season (Fig. 2 d), the runway temperature is higher than the screen temperature, the maximum difference being 1°·1C at 0300 GMT during October. The difference decreases from 0300 GMT during October and 0600 GMT during September to a minimum value at 1200 GMT whence again it tends to increase slightly. At 1800 GMT, the difference is less than 0°·4 C. From 1800 to 0000 GMT, the same difference is maintained during September while the difference slightly increases (by 0°·2 C) during October. The higher values of runway temperature might be due to radiation effect.

From the above discussions the following interesting features are brought out—

1. Except during January and February, at 0000 GMT, the runway temperature is higher than the screen temperature.

2. At 0300 GMT, the runway temperature is higher than the screen temperature, the maximum difference being during the winter season.

3. At 0600 GMT, the runway temperature is higher than the screen temperature, the maximum difference being during pre-monsoon season.

4. At 0900 GMT, the runway temperature is generally higher than the screen temperature, the order of difference being 0°·3C to 1°·1C.

5. At 1200 GMT, during winter and pre-monsoon seasons, the runway temperature is lower than the screen temperature, while during the monsoon and post-monsoon seasons, the runway temperature is higher than the screen temperature.

6. At 1800 GMT, the runway temperature is generally higher than the screen temperature except during the period January—March when the runway temperature is less than the screen temperature.

4. Concluding Remarks

It is generally expected that the difference of temperature readings recorded over the runway and those recorded in the Stevenson Screen in the observatory enclosure should be less than 1°C. It is seen that the above expectation is borne out fairly well. To be more precise, it is seen that the difference of temperature readings is less than 1°C except at 0300 GMT during October to May, 0600 GMT during March to May and 1800 GMT during December. It is further seen that the difference of temperature readings is less than 1°C except during the winter and pre-monsoon seasons for a short period from a couple of hours after sunrise to about 0600 GMT. During the monsoon and pre-monsoon seasons, the difference of the temperature readings is almost always less than 1°C. Now, coming to the sense of the difference, it is seen that the runway temperature is generally higher than the screen temperature except at 0000 GMT during January to February, 1200 GMT during November to May and 1800 GMT during January to March. From the seasonwise distribution it is inferred that the runway temperature is higher than the screen temperature except during the night time for the months January to March. One of the reasons for this temperature difference may be attributed to the radiation effect (Angstrom 1928, Moller 1936, Pasquill 1949, Sutton 1953, and Homen 1897) due to the difference in the structure of the runway and observatory enclosure. The other important factors which govern the temperature of air near the ground are surface wind, exposure to the observation site, difference in the two types of thermometers etc.

The conclusions arrived at above are, however, tentative due to the limitations mentioned earlier. The study is continued with special care to see that the data on a larger number of occasions are available so that more rigid conclusions would be arrived at. The result of the above study will be reported in due course.

5. Acknowledgements

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