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A TECHNIQUE FOR ESTIMATION OF PERSISTENCE OF AIR TEMPERATURE OF A PLACE WHERE HOURLY DATA ARE NOT AVAILABLE

The temperature is one of the most important parameters that influences human comfort as well as performance of materials. There are certain rather narrow limits of temperature, which if exceeded, lead to a deteriorating effect on men and materials. According to Winslow and Harrington (1949), when the temperature of the thermal environment falls below or rises above a critical value (30 deg. C for semi-reclining nude subject) the skin temperature begins to fall or rise. Moreover, it is uncomfortable and painful when the local skin temperature, even over a small area of one cm^2 falls below 18 deg. C or rises above 45 deg. C (Hardy *et al.* 1970). Newburgh and Milton (1945) showed that seven hours' exposure at 6 deg. C will produce the same deteriorating effect on the human body as one hour exposure at — 14 deg. C with the same clothing and activity. So it is not merely the absolute value of the temperature but also its duration of persistence that determines fitness in different fields of activities.

2. Detailed meteorological data, such as hourly readings of temperature extending over the whole year and for several years, are not available at many places in the country. For utilizing the limited temperature data, Brooks (1950), therefore, constructed an approximate cumulative curve (without detailed hourly readings of air temperature) by using the mean temperature, mean daily maximum and minimum temperatures, mean monthly maximum and minmum temperatures and highest and lowest recorded temperatures.

3. In this note an attempt has been made to estimate the persistence of temperatures at or below a particular threshold for a place where only the maximum and minimum temperatures are being recorded. It has been noted that roughly 1% of hourly observations of air temperature in a month lie at or below the mean monthly lowest temperature, 10% at or below the mean daily minimum, 50% at or below the mean temperature of the month, 90% at or below the mean daily maximum and 99% at or below the mean monthly highest temperature (Table 1). There is some deviation from the observations of Brooks (1950). To explain the probable cause for the deviation, further studies are needed.

TABLE 1

Mean of	Temp. (°C)	Cumulative frequency (with total as unity)	Probit
Monthly lowest	22.5	.01	2.67
Daily minimum	27.3	.10	3.72
Month	34.4	.50	5.00
Daily maximum	41.6	.90	6.28
Monthly highest	45.5	.99	7.33

4. The maximum and minmum temperatures data of Jodhpur for May have been taken from *Climatological Tables of Observatories in India* (1967). Mean temperature of the month has been taken as average of the mean daily maximum and mean daily minimum temperatures. The data are shown in Table 1.

5. It is assumed that variation of air temperature in a month follows the normal distribution. If t is the temperature, and P, the proportion of hours for which the temperature has persisted at or below t deg. C in a particular month, then P is given by :

$$P = \int_{-\infty}^{\infty} \frac{1}{\sigma\sqrt{2\pi}} \quad \exp \quad \left\{\frac{-(x-\mu)^2}{2\,\sigma^2}\right\} dx \quad (1)$$

where μ and σ are the mean and standard deviation of the normal curve.

5.1. The parameters of distribution (1) can be easily estimated with the help of probit analysis (Finney 1977). Probit value for a particular P is defined as a unit normal variate *plus* 5. As an illustration, the detailed procedure for estimation of parameters for the month of May have been given below :

5.2. Probit values corresponding to various P have been noted from Statistical Tables (1963) and shown in Table 1. These values have been plotted in Fig. 1. An eye-fit straight line is drawn. The constants a and b of the line are calculated as follows :

$$b = (y_2-y_1)/(x_2-x_1)=0.1931$$
$$a = y_2-b\ x_2 = -1.6275$$

where (x_1, y_1) and (x_2, y_2) are any two convenient points on the line.

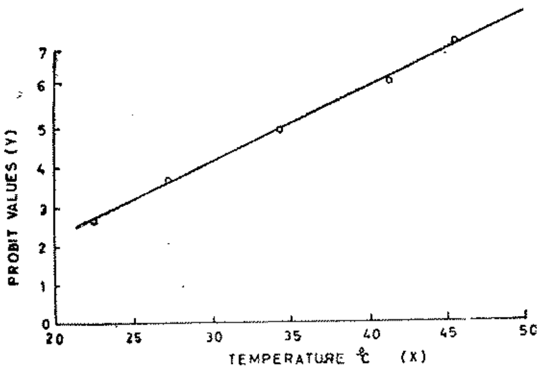

Fig. 1. The first estimate of probit regression line

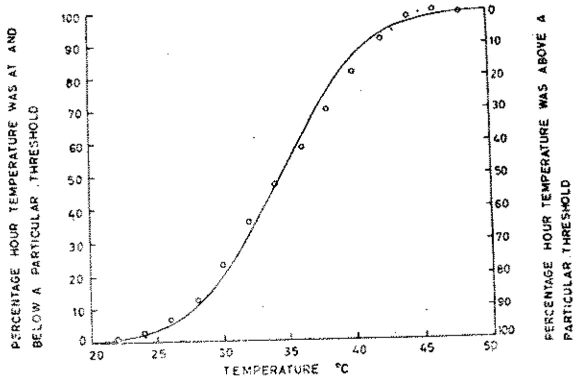

Fig. 2. Persistence of temperature above and below different thresholds

Thus the first estimate of probit regression line,

$$Y = -1.6275 + 0.1931X \quad (2)$$

$\mu = 34.3$ °C (50% threshold or mean temperature of the month)

$\sigma = 1/b = 5.18$

5.3. If the probit regression line in Fig. 1 shows a good fit, further refinement is not required. Otherwise, the estimates are further improved by iterative process of the maximum likelihood solutions as indicated by Finney (1977).

5.4. For different values of temperature, (x) values of probit have been calculated with the help of Eqn. 2. Corresponding to various values of probit, proportions are noted from the statistical tables and these have been shown by a continuous curve in Fig. 2. Observed values estimated from hourly data recorded by Defence Laboratory, Jodhpur, (5 year's data) are also shown in the same figure by circles for comparison. No significant difference was observed at 1% level.

5.5. In this way, persistence of temperature at or below a particular threshold can be estimated approximately for any month for a place where hourly data have not been recorded but maximum and minimum temperatures have been collected. Even if the hourly data are available computation of frequency and persistence of temperatures will be laborious.

6. It is hoped that results of such type of analysis as presented in this paper would be useful to planners and designers in assessing the operational reliability of equipment and requirement of protective clothing under adverse environments. Such information could be utilized by engineers in connection with heating and air conditioning of buildings. It may also be useful to agricultural meteorologists and plant pathologists.

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