ABSTRACT

Meteorological information on different time scales is needed for estimating long term performance, of environmentally driven systems in general and of solar energy systems in particular, by simulation methods or by simplified design methods. The primary meteorological variables of interest are, solar radiation, ambient temperature, illuminance and wind velocity on different time scales. In the absence of measured meteorological information, often use of correlations to generate solar radiation and ambient temperature on different time scales is resorted to. This procedure is being referred to as synthetic data generation. Measured information as well as relations dealing with illuminance are far less available compared to solar radiation and ambient temperature. When measured data are not available, advantages of using synthetic data include the convenience of working with a (reduced) data set that can be generated locally, integral with the simulation or other software packages.

In order to make available missing information or establish relations of general validity studies undertaken include the following. Developing and validating a) cumulative frequency distributions for hourly ambient temperature, b) cumulative frequency distributions for hourly clearness indices, c) interrelations between hourly and daily global and diffuse solar illuminance d) cumulative frequency distributions for daily global illuminance and e) cumulative frequency distributions for hourly global illuminance. Thus the meteorological variables of interest attempted to be generated in the present studies from corresponding average values are, hourly ambient temperature, clearness indices, daily and hourly global illuminance. In addition interrelations between daily and hourly global and diffuse illuminance also have been developed.

Throughout the present studies data base of 56 primary locations and 183 secondary locations of TMY2 (Typical Metrological Year) has been employed. In addition, measured global and diffuse solar radiation and illuminance information of 6 IDMP (International Daylight Measurement Programme) locations also has been employed.

To depict the cumulative frequency distributions for the variables (hourly ambient temperature, clearness index and daily and hourly global illuminance) mentioned, normalized variables have been employed. The normalized variables contain the maximum and minimum values of the variable in addition to the variable itself (to be predicted) and the average value of the variable appropriate to the time scale. These normalized variables accommodate differing climates and seasons.

Two forms of equations have been developed to depict the cumulative frequency distributions. The linear form is amenable for applying for continuous values of the normalized monthly average parameter. When data are not available, correlations to estimate the maximum and minimum values of the variable needed, also have been developed. The relations developed have been validated by comparing against the values for TMY2 locations widely differing in climate and latitudes and 6 IDMP stations. A procedure has been devised and validated to generate hourly values with realistic hour to hour variation during a day by employing the cumulative frequency distributions for hourly ambient temperature, clearness indices and global illuminance.

It has been found that the interrelations that exist between hourly (or monthly average hourly) and daily (or monthly average daily) global and diffuse radiation are applicable for global and diffuse illuminance also, by suitably defining the relevant ratios and appropriate modification.

Key words: meteorological information, synthetic data generation, cumulative frequency distributions, time scales, ambient temperature, clearness index, illuminance, interrelations