Mean radiant temperature (TMRT) is an important component of human thermal comfort indexes, but is difficult to measure and model. A method was developed to calculate instantaneous values of TMRT based on the geometry and dimensions of the urban canyon, vegetation leaf area index, meteorological data (temperature, relative humidity and solar radiation), surface emissivity and reflectivity, and surface temperatures in the urban canyon, which are easily measured with a handheld IR thermometer. The advantage of this method is that it can be used for experimental work in the urban canyon without the need for deploying several expensive radiometers, eg. four-flux net radiometers. The calculation procedure involves calculation of extraterrestrial, direct and diffuse solar radiation, sky long wave radiation, and reflections and emission of radiation from the various surfaces.

A software package, named Mr. T, was developed as a final project of two engineering students, to include the various calculations and allow determining TMRT from the appropriate input data. The package has a friendly user interface and can accept data input manually or from EXCEL type spreadsheets. The calculation procedure and software were tested in two urban settings at and near Tel Aviv University and results were not significantly different from those obtained with four-flux net radiometers. The software package will be supplied freely to the research community. The calculation procedure and software should be important for use in determining thermal comfort in the appropriate models.

Below are screen shots of the ‘Mr. T’ user interface, which defines the scenarios for an urban canyon (upper shot) or an open space like a park (lower shot). Surface properties are in a lookup table which can be updated by the user.

Below is the data file produced by the ‘Mr. T’ software for the validation data set. The columns shaded yellow are input to the program as an excel data file, and the columns shaded green are calculated and output by the software to the same file.

The Tmrt calculation procedure was initially developed and implemented as a series of Excel spread sheets for a project that investigated the influence of vegetation on urban climate (Bar et al., 2013). On the left is a description of several of the experimental sites studied in Beer Sheva, Israel. Below are results of Tmrt for a ‘standing man’ in the parks and an urban sidewalk in the summer. T_mrt in the shade of trees (Prosopis and Tamarix) in the city park is reduced by more than 25°C.

References:

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