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Possibilities and limitations of applying thermal indices and micro scale bioclimate models in urban environments

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In order to analyze urban climate and bioclimate several meteorological input parameters are required (air temperature, air humidity, wind conditions and radiation fluxes). These parameters in combination with thermo-physiological information (metabolism and clothing) are the input for the calculation of thermal indices, which can describe the integral thermal effect of the atmosphere on the human body. All the best known thermal indices (e.g. Physiologically Equivalent Temperature (PET), Universal Thermal Climate Index (UTCI), Perceived Temperature (PT), ...) require the same input parameters.
In urban areas all the input parameters are modified, because of the different morphological characteristic and physical properties of the surfaces within a city. In this context the strongest modifications occur in the wind conditions and radiation fluxes. Radiation is modified mostly by the aspect ratio (height and width of streets or obstacles), orientation and physical properties (albedo, permeability and heat storage) and they have to be known for the estimation of the mean radiant temperature as well as short- and long wave radiation fluxes in general. In addition urban areas modify wind speed and direction because of increased roughness and distribution of obstacles. These two highly volatile and important factors modify the thermal comfort conditions strongly. They can be easily modified by urban planning and architectural measures in the micro scale.
For the estimation of thermal indices and the quantification of factors influencing thermal comfort micro scale models are available.
One of these models is the RayMan model, which can calculate mean radiant temperature and thermal indices (PMV, PET, SET*, UTCI and PT). For the calculation of mean radiant temperature RayMan is able to calculate short and long wave radiation fluxes based on several methods of spatial inputs environments (fish eye photos, geometrical characteristics of obstacles, free- drawing) and providing output of mean radiation temperature, shade, sunshine durations and thermal indices. In addition, input parameters can be adjusted and modified in order to estimate effects of aspect ratio and orientation of obstacles (buildings and trees). Another model is the SkyHelios model. In contrast to RayMan model, SkyHelios allows for spatial calculations. It calculates and visualizes sky view factor, shade and radiation fluxes in very high spatial and any temporal resolution. Roughness can be calculated for different wind direction sectors and it can be used for the calculation of wind speed and thermal indices. SkyHelios supports the calculation of PET, UTCI and PT. Various common spatial data formats can be used as input for the calculations.
The application possibilities of the models cover several fields of human-biometeorology including urban climate issues for micro scale.