EMS Annual Meeting Abstracts
Vol. 8, EMS2011-261, 2011
11th EMS / 10th ECAM

Forecasting the weather
- ensemble techniques
in probabilistic weather prediction

Mean radiant temperature - a key variable in urban human-biometeorology

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Besides trends of climate variables, regional climate change in Central Europe is characterized by extreme heat waves like in summer 2003, which will be the normality in summer starting in the middle of the 21st century. Facing the intensification of extreme heat waves, the importance of the human-biometeorologically significant assessment of the thermal component of urban climate is increasing. It provides the basis for urban planning methods, to mitigate the negative effects of large-scale heat on the local scale of citizens. As urban planning is long-acting, these methods have to be developed even now and not just after an extreme heat wave.

Despite the tendency of many researchers to focus on air temperature, radiant exchange is the most dominant factor affecting human thermal comfort within urban structures during extreme summer heat. The radiant heat absorbed by citizens can be quantified by the mean radiant temperature Tmrt. It represents the most significant meteorological variable to quantify human thermal comfort during clear sky weather in terms of a thermo-physiologically assessment index like the worldwide used physiologically equivalent temperature PET. Therefore, Tmrt can be regarded as a key variable in urban human-biometeorology.

Tmrt can be determined by simulation models or direct measurements of the short- and-long-wave radiation flux densities from the three-dimensional surroundings of the human-biometeorological reference person, which is used in the assessment concepts of urban human-biometeorology. Results of comparisons between both types of methods are already available in the literature.

With respect to the application of planning methods to mitigate large-scale heat effects in the local scale of citizens, the objective of the presentation is to show and discuss the spatio-temporal variability of the single radiation flux densities within complex urban structures and its consequences for Tmrt and PET. For this purpose, results of measurements of all variables to calculate PET including the short- and long-wave radiation flux densities from the three-dimensional surroundings of the standardized reference person were analyzed. The measurements were conducted on typical summer days within different urban structures in Freiburg, the warmest city in Germany, by use of specific human-biometeorological stations. Although the total long-wave radiation flux density absorbed by the reference person has a distinctly higher contribution to Tmrt in contrast to the total short-wave radiation flux density, Tmrt is predominantly determined by the direct solar radiation, which also governs the long-wave radiation flux densities. Therefore, shading of direct solar radiation, but without an increase of long-wave radiation flux densities as for awnings, represents an effective method to lower heat stress for citizens. On principle, this qualitative recommendation is already known for a long time. But the innovative aspect is that this recommendation can now be quantified in a way, which is directly related to citizens.