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Integration of Thermal Indoor Conditions into Operational Heat Health Warning Systems

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The 2003 heat wave in Western Europe with altogether 35,000 to 50,000 deaths in Europe, several thousands of which occurred in Germany, has clearly pointed out the danger arising from long periods with high heat load. As a consequence, Germany, as many other European countries, has started to implement a Heat Health Warning System (HHWS).

The German HHWS is based on the 'Perceived Temperature'. The 'Perceived Temperature' is determined through a heat budget model of the human organism which includes the main thermophysiologically relevant mechanisms of heat exchange with the atmosphere. The most important meteorological ambience parameters included in the model are air temperature, humidity, wind speed and radiation fluxes in the short-wave and long-wave ranges. In addition to using a heat budget model for the assessment of the thermal load, the German HHWS also takes into account that the human body reacts in different ways to its thermal environment due to physiological adaptation (short-term acclimatisation) and short-term behavioural adaptation.

The restriction of such an approach, like the majority of approaches used to issue heat warnings, is that the threshold for a warning is generally derived from meteorological observations and that warnings are issued on the basis of weather forecasts. Both, the observed data and the weather forecasts are only available for outside conditions. The group of people who are most at risk of suffering from a heat wave, however, are the elderly and frail who mainly stay inside. The indoor situation, which varies largely from the conditions outside, is not taken into account by most of the warning systems.

To overcome this limitation the DWD, in co-operation with the Fraunhofer Institute for Solar Energy Systems, has developed a model which simulates the thermal conditions in the indoor environment. As air-conditioning in private housing in Germany is not very common, the thermal indoor conditions depend on the outside conditions, on the building characteristics, and on the inhabitants' behaviour.

The thermal building simulation model estimates the indoor heat load based of the predicted meteorological outside conditions by calculating the operative indoor temperature. The building types prevailing in Germany are quite heterogeneous. It was therefore decided to use for the thermal simulation a so-called "realistic worst-case" building type. In addition, a differentiation is made between two types of user behaviour: the active user opens the windows during the cold hours of the day and uses shading devices whereas the passive user does nothing to keep the heat outside.

Since 2007, the DWD has been using the simulation of the indoor thermal conditions as an additional source of information for heat warnings. The information on the indoor conditions has proved very valuable for the decision whether to issue a heat warning or not.