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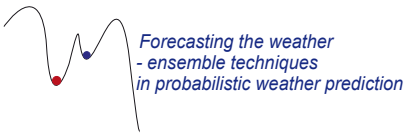

How to integrate thermal indoor conditions into heat warning systems?

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The 2003 heat wave in Western Europe with a death toll of 35,000 to 50,000 people has clearly pointed out the danger arising from a long-lasting heat load. As a consequence of it many European countries have implemented Heat Health Warning Systems (HHWS). HHWS use weather forecasts to generate warnings, which trigger health interventions. As there is no official definition of a heat-wave, I wide range of criteria for issuing heat warnings is used. Epidemiological studies have shown that health impacts of heat are greatest if there is a strong heat load during day time and if there is only insufficient nocturnal cooling. In addition, health impacts are increasing for longer lasting heat-events. Often, a heat warning is issued if several criteria are met at the same time. In Germany, for instance, a heat warning is issued if on two consecutive days Perceived Temperature at 12 UTC and daily minimum air temperature in the night between those two days exceed specific thresholds.

A restriction of most HHWS is, that the warnings as well as the warning criteria are derived from outside conditions. However, the group of people most at risk of suffering from a heat-wave are the elderly and frail, who spend most of their time inside buildings. HHWS often try to take this into account indirectly by including the duration of the heat situation and the lack of nocturnal cooling. Though, this approach is not very satisfying because building properties as well as the user's activities modify the thermal load indoors.

The Deutscher Wetterdienst (DWD) uses a building simulation model developed by the Fraunhofer Institute for Solar Energy Systems to estimate the thermal indoor conditions since 2007 as an additional source of information, that facilitates the decision whether to issue a heat warning or not. This building simulation model could not be integrated into the operational HHWS. Thus, it has been revised in 2010 and run in a pre-operational mode in summer 2011. The thermal building simulation module estimates the indoor heat load by calculating the operative indoor temperature and the Predicted Mean Vote. The building types that are prevailing in Germany are quite heterogeneous. Nevertheless, only three different standard building types are used for the thermal indoor simulation. In addition, the indoor module can account for different types of user behaviours (e.g. opening and shading of the windows).

It is planned to issue heat warnings based on criteria which combine heat load outside during day time and indoor heat load during the night. In this way the main factors influencing heat related health effects can be taken into consideration: (1) the absolute heat load during hot days which may cause directly heat related health impacts (e.g. heat stroke); (2) the exposure to longer-lasting "slight" to "moderate" heat load also during the night that may contribute to indirect heat-related health impacts (e.g. cardio-vascular problems). In the current HHWS point 2 has indirectly been accounted for by minimum air temperature and the duration of two days or longer.