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Heatwave impacts on urban indoor air temperature assessed through citizen science observations in the Netherlands

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Due to climate change and urbanization, the world's population is increasingly exposed to extreme heat, posing a threat to public health. Despite people spending ~90% of their time indoors, heat effects in buildings have been studied far less than outdoor heat island effects. This study aims to observe, understand and model the behaviour of indoor air temperatures (T_{in}) during summer heat. As a proof of concept, we present and analyse up to 27 years of individual T_{in} timeseries of seven citizen weather stations (CWS) across the Netherlands. First, we find that typically T_{in} increases slower, but also cools down slower than T_{out} with a lag difference of ~130 minutes in the diurnal cycle. We demonstrate that nocturnal indoor human thermal comfort (HTC) can be worse than outdoor HTC even for days after a heatwave.

Second, to model T_{in} behaviour, we simulate six-hour changes in T_{in} behaviour with a physics-based statistical model by Vant-Hull et al. (2018) that has an outdoor conduction, indoor conduction and solar transfer component. Preliminary results of this computationally-fast model for each of the seven houses are promising, showing on average a R-squared of 0.74 and a root mean squared error of 0.13 K. Third, we are also interested in how T_{in} may evolve due to climate change. We study this by converting the T_{in} measurements to 2050 and 2085 values based on the Royal Netherlands Meteorological Institute 2014 climate scenarios.

Finally, in the next research step, we will scale up our proof-of-concept analyses to 100 indoor CWS placed in Amsterdam. The participating households receive a CWS for three years to measure their indoor climate – temperature, relative humidity, CO_2 concentrations – in the bedroom and living room. Based on our insights, we will make recommendations for climate-sensitive urban design to reduce indoor heat stress.