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Standardization of 1-m spatial resolution urban heat maps of Physical Equivalent Temperature to facilitate climate stress tests in the Netherlands

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In the Netherlands, all municipalities have to perform climate stress tests for water and heat in 2019. So far many contrasting urban heat maps are produced with different metrics and methods. To unify the stress tests, here we attempt to standardize the urban heat maps by selecting the Physical Equivalent Temperature (PET) as appropriate metric to evaluate heat stress. Two kinds of heat maps are recommended; an afternoon averaged heat map (12-18 local time) of a 1:1000 heat day, and a map which indicates the yearly number of hourly PET exceedances over 29 ºC. In addition, an outlook is given for the year 2050.

An empirical regression model for PET has been developed, based on a variety of weather data and street configurations in the human energy balance model Rayman. Meteorological components in this model include the air temperature and humidity, global radiation and wind speed originating from a WMO reference weather station.

The urban air temperature is estimated with a verified diagnostic equation determining the UHI based on routine meteorological observations and straightforward urban morphological properties as sky-view factor and vegetation fraction (Theeuwes et al, 2017). We estimate the wind speed in the city based on a method described by MacDonald et al. (2000) which reduces the free wind speed based on the wall surface area index. This method is extended by incorporating trees, which additionally reduce the wind.

Here, PET heat maps are demonstrated for the small city of Wageningen (The Netherlands), and are validated against traverse observations of PET on a hot sunny day. The modelled PET and the correlation are in quite good agreement with the measurements. Wind speed is the most challenging feature, due to its unsteady behaviour in cities.