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The effect of climate change on urban environment under the episodes of heat waves using a fine resolution non-hydrostatic numerical model

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Heat waves (HW) associated with climate change and increased near-surface air temperature can be considered as a climatic hazard for people (and the environment), especially in built-up areas, where the urban-heat island (UHI) phenomenon causes further heat stress for the human body. Such extreme events in the past and future can be analysed on the basis of regional climate model simulations with definitely finer horizontal resolution than the global climate models (GCM), however, downscaling over very complex terrains - like urban areas - need special attention and even finer scale.
The non-hydrostatic WRF (Weather Research and Forecasting) model is used here to estimate the potential effects of climate change on urban environment under the episodes of extreme heat conditions. In order to keep the stability of the simulations, the entire downscaling from 1.25° (GCM) to 1 km (WRF) is carried out in several steps using gradually smaller domains embedded to each other. In our configuration the initial and boundary fields needed by WRF are provided from the output fields of the RegCM regional climate model (RegCM4.3) simulations (with 10 km resolution resulted from a double nesting process from the coarse GCM outputs) using RCP4.5 and RCP8.5 scenarios.
The analysis focuses on selected heat wave episodes from the RegCM simulations during three periods (past: 1971–2000; future: 2016–2045 and 2061–2090). The simulations are carried out for Budapest, the capital of Hungary located in the Carpathian Basin, with the WRF model coupled to multilayer urban canopy parameterisation. With our updated landuse and urban characteristics database, the model is able to reproduce the UHI with an appropriate fine horizontal resolution, and the spatial inhomogeneity of its structure. Among the numerous derived fields those surface variables will be analysed that have substantial impact on the thermal processes in urban areas and the UHI.
In case of several tested HW definitions, the RegCM simulations project longer lasting, more frequent and more intense HW events in the selected future periods for both analysed scenarios. For the RCP4.5 scenario, HW days become 3–6 times more frequent with respect to the reference period, while the increase is 5–9 fold for the RCP8.5 by the end of the century. Furthermore the durations of HWs are also projected to become longer with 1–2 days for the RCP4.5, and with 3–4 days for the RCP8.5 scenario. For the selected summertime HW events, our preliminary results show that the more intense modelled nighttime UHI (on average 2–3°C) will decrease in both future periods (0.15–0.25°C), while a slight increase is analysed in the daytime intensities. The ultimate aim of this study is to estimate the potential changes of UHI caused by climate change over Budapest, which can assist to develop local/regional adaptation and mitigation strategies.