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Dynamical downscaling study for urban environment using non-hydrostatic WRF model to estimate the potential local impacts of climate change

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The RegCM regional climate model is designed to capture the regional meteorological processes with finer horizontal resolution than the global climate models. However, the scale of urban processes requires even finer scale, and hence, definitely non-hydrostatic approach. Furthermore, in our target area, i.e. the Carpathian Basin, the built-up areas are not represented well enough in the RegCM land use database (this is especially true for Budapest, the capital of Hungary). That is why a downscaling method is essential to use in order to analyse the effects of climate change over a complex terrain such as the urban environment. In the present model configuration, downscaling is carried out with the non-hydrostatic, mesoscale, limited-area Weather Research and Forecasting (WRF) Model, with updated surface databases, such as land use (with 5 urban surface categories), climatological albedo, topography, and spatial distribution of urban parameters. To initialise the WRF, the RegCM (RegCM4.3) output fields (using RCP4.5 and RCP8.5 scenarios) are used at every 6 hours on selected dates (heat wave events) during three periods (past: 1971-2000; near future: 2016-2045, and far future: 2061-2090). During the initialisation the necessary binary files, which include the meteorology for the model, are created from the calculated and derived regional output fields of RegCM. Earlier studies showed that the frequency, lifetime and intensity of heat waves are projected to last longer and become more intense, which will cause further stress both for the human body and the environment. Based on these considerations, the WRF model coupled to multilayer urban canopy parameterisation (BEP+BEM: Building Environmental Parameterisation and Building Energy Model) was run only for the heat wave days in July and August from the aforementioned periods in the past and in the future, as well. In order to keep the stability of the simulations, the entire downscaling is carried out in several steps using gradually smaller domains embedded to each other. Thus, three embedded target areas have been determined for this modelling study. The largest external area covers the whole Pannonian region with 10 km horizontal resolution, whereas the innermost domain covers Budapest and its surroundings with 1 km grid resolution. Among the numerous derived fields those surface variables are analysed, which have substantial impacts on the thermal processes of urban areas. To estimate the heat stress change in the urban environment during the 21st century, the temperature differences between the urban and rural areas (i.e. the Urban Heat Island, UHI intensity) are also analysed.