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Modelling the cooling effect of Nature-based Solutions in densely built-up areas for a case study Vienna, Austria

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Reducing the Urban Heat Island effect and local implementation of climate adaptation strategies, especially Nature-based Solutions (NbS), are one of the key aspects of tackling climate change impacts in urban areas. Increasing green infrastructure of open spaces and buildings, such as implementing green roofs, unsealing of paved surfaces and planting vegetation, particularly increasing the number of street trees and park areas, is considered to have a cooling effect and can help to reduce extreme heat. In this study we examine the possibility to implement different NbS in a densely built environment and evaluate its cooling performance. The evaluation is done on a micro-scale using the ENVI-met model for a selected area in the City of Vienna and the cooling effect is further analysed in case these measures are implemented on a city-scale by using the MUKLIMO_3 urban climate model.
The climate adaptation scenarios with different NbS included: 1) reduction of paved surfaces, 2) increase in surface albedo of paved surfaces, 3) implementation of green roofs, 4) new parks including trees and low vegetation and 5) a combination of NbS. The extent of NbS was quantified for the selected area and proportionally scaled for all densely built areas in the city. Simulations were performed for a representative clear-sky heat day for each NbS scenario as well as for the combination of all NbS.
The highest cooling effect is found for a combination of all NbS. The results show similar cooling intensity both in microscale and city-scale simulations. For a realistic proportion of NbS implemented in the models, a moderate cooling effect of about 1-2°C can be achieved. In case of city-scale simulations, the maximum difference of about 1.4°C is found in the densely-built areas where the measures were applied. Minor cooling effect can be detected in the surrounding areas as well.
Additional modelling simulations with variable parameters describing land-use properties were conducted to estimate the uncertainties in the modelling results. Based on the different representation of land use characteristics in the model, variations in the spatial pattern of heat load can be found. The cooling effect also varies spatially, depending on the local implementation of NbS. However, the results show similar cooling efficiency of NbS with minor influence of the background data and the method applied.