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Urban heat extremes in REMO2020-TEB convection-permitting regional climate simulations over Europe

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Recent heat extremes have highlighted both existing and emerging vulnerabilities in European cities, underscoring the need for robust climate information to support future urban adaptation. These risks are projected to intensify under climate change, particularly in densely populated urban environments. Accurately representing urban surface and atmosphere interactions therefore remains a key challenge for regional climate modelling at city scales. Convection-permitting regional climate models (CPRCMs) resolving climate processes at the kilometer-scale provide new opportunities to simulate urban areas and their local climate processes through urban parameterizations.

We investigate how urban representation modifies present-day and future urban climates in CPRCM simulations over Europe. We use the regional climate model REMO2020 at 3 km horizontal resolution, newly coupled with the Town Energy Balance (TEB) urban canopy model. Historical and future climate simulations are conducted for the Horizon Europe project Impetus4Change over two European domains covering cities across contrasting continental and maritime climates, including southern and northern European urban environments.

The analysis focuses on urban heat extremes and their diurnal characteristics, including urban-rural temperature contrasts and the persistence of elevated night-time temperatures. The added value of the urban canopy model TEB is assessed compared to a bulk approach and coarser-resolution simulations in REMO. By comparing present-day conditions with end-of-century climate projections, we assess how urban heat extremes and urban-rural temperature patterns evolve with warming and whether urban effects scale with increasing background temperatures.