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High resolution modeling of urban climate on the example of Stockholm

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The urban share of the world population has reached 54% in 2015 and will grow to 66% by 2050 according to projections. Under the urban expansion and the climate change, the urban areas are facing a number of environmental problems such as extreme weather and air pollution. Although observations show that cities impact local weather and climate, simulation of urban effects remains a challenge in many land-surface models which were developed for low-resolution atmospheric models.

High resolution climate models with better representation of land surface properties and small scale atmospheric process can reproduce the complex and nonlinear urban-rural weather and climate interactions relatively accurately. The objective of the study is to further understand the physical processes of urban climate by using a high resolution climate model. To this end, we carry out simulations at a range of different resolutions. The large scales are described using ERA-Interim, while the urban scales are simulated with a high-resolution (3 km – 300 m) model HCLIM-AROME. We also run the corresponding offline land surface model (SURFEX with the Town Energy Balance (TEB) urban canopy model) forced by the atmospheric data from lower-resolution HCLIM simulations. The study area is Stockholm (including its surroundings) with mixed built up, water and nature surfaces.

We present the analysis of the multi-scale simulations and the validation against various urban observations. By comparing the land-atmosphere coupled runs with that of uncoupled runs, we aim to understand the role of land-atmosphere feedback in high resolution urban modeling. We will also investigate the benefits of using very high resolution for urban climate models.