



# International Max Planck Research School on EARTH SYSTEM MODELLING

## Urbanization impacts on the climate in Europe

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## Abstract

This work is focused on studying urbanization effects on the climate in Europe at local and regional scales. The objectives include three topics: 1) studying impacts of urban land cover on the climate, 2) predicting impacts of different forms of urban development on the climate and 3) estimating urbanization-driven climate effects on the land carbon uptake in Europe. Numerical models of climate and terrestrial ecosystem are used to address these questions.

Effects of urban land cover on the climate are isolated using the PSU/NCAR Mesoscale Weather Prediction Model (MM5) with a modified land surface scheme based on the Town Energy Balance (TEB) model. For estimating effects of climate changes on the land carbon uptake, the Biogeochemical Terrestrial Ecosystem Model BIOME-BGC is used.

It was found that conversion from rural to urban land results in significant changes of the near-surface temperature: the diurnal temperature range in regions of land cover perturbation was reduced in average by  $-0.73 \pm 0.54^\circ\text{C}$  in winter and  $-1.26 \pm 0.71^\circ\text{C}$  in summertime. Inclusion of urban land resulted in a reduction of total precipitation in Europe, although urban areas alone receive more precipitation in winter ( $+0.09 \pm 0.16 \text{ mm day}^{-1}$ ) and less precipitation in summer ( $-0.05 \pm 0.22 \text{ mm day}^{-1}$ ). The study suggested that an expansion of urban area by 100% would result in an even stronger reduction of urban summer precipitation ( $-0.17 \pm 0.44 \text{ mm day}^{-1}$ ) and urbanized regions of Southern Europe would experience the strongest reduction.

A possible way of improving city's thermal regime by managing urban vegetation was studied for Berlin and Madrid urban areas. It was found that replacing urban grass lawns by tree stands would help to reduce the near-surface temperature by up to  $1^\circ\text{C}$  and to mitigate urban heat island.

The urban climate contribution to the net carbon balance in Europe was found to be rather small as compared to fertilization effects provided by urban  $\text{CO}_2$  and  $\text{NO}_x$  pollution.