

Street-level assessment of urban scenarios by the means of newly developed urban surface model for LES model PALM

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Summary

Urban mitigation scenarios for the development area in Prague, Czech Republic were calculated by the LES model PALM with the recently developed urban surface model which accounts for radiation and other energy processes inside the urban canopy layer. Studied scenarios included the effects of tree planting and surface material adjustments on the surface and air temperatures and NO_x concentrations during a summer heat wave episode. It was shown that a positive effect (cooling) in temperature can be accompanied by the increase of NO_x concentration. Thus the impact of urban mitigation scenarios has to be carefully assessed from all relevant points of view.

Introduction

- As a result of climate change, it is expected that extreme events such as heat waves will become more frequent.
- Urban areas are often vulnerable and poorly prepared to respond to such episodes.
- Our goal is to perform modelling on street-level scale, assess suitable adaptation measures and evaluate their impact on thermal comfort of inhabitants and air pollution.

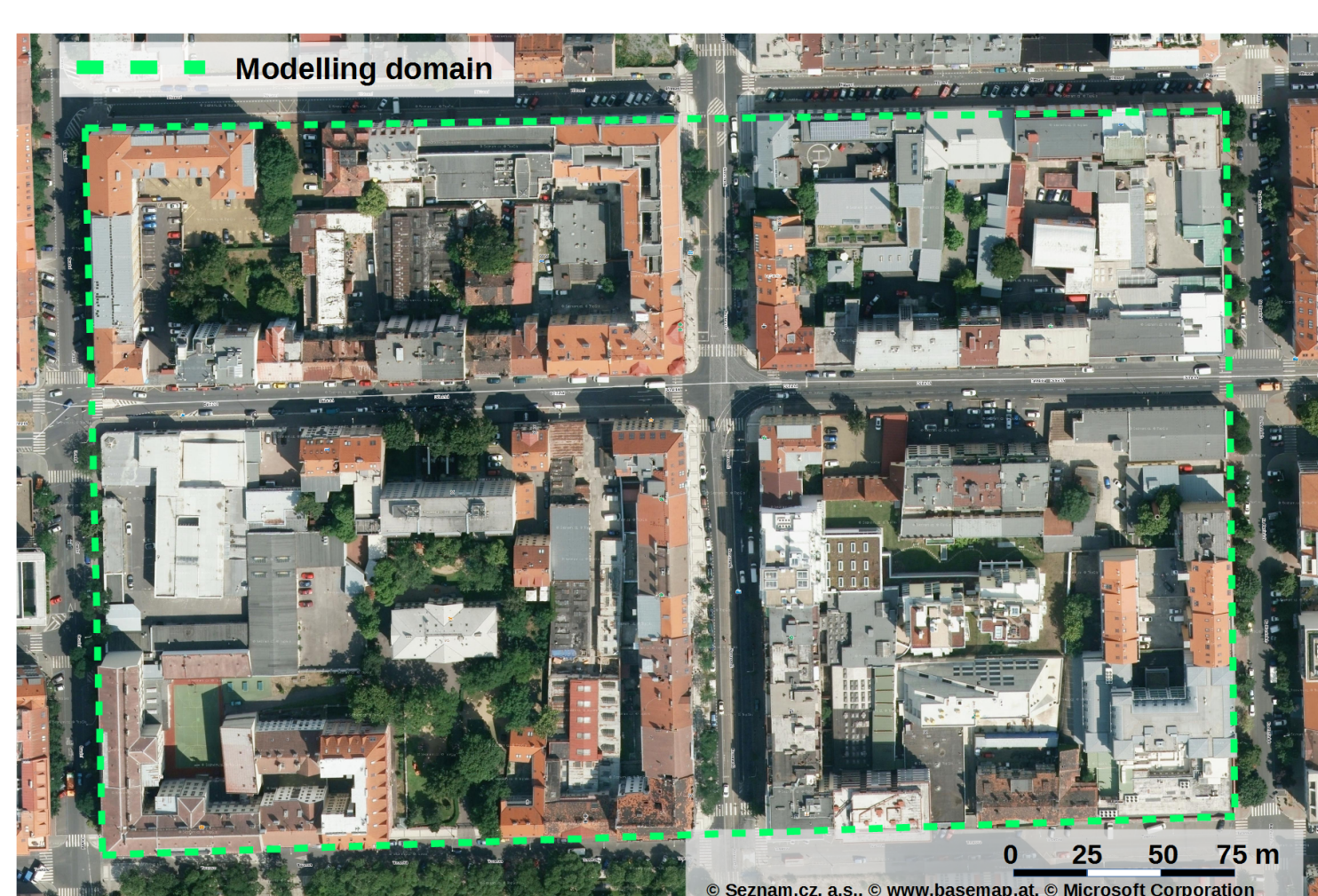
Model & domain

Model

- We have developed a new urban surface model (USM) and incorporated it into LES model PALM to account for complex processes in urban canopy (Resler et al., 2017, Geosci. Model Dev., in print).
- Main parts of USM
 - Urban surfaces (ground, walls, roofs)
 - Radiation transfer model for urban canopy
 - Energy balance of the surface skin layer
 - Heat transfer in material
 - Plant canopy (trees, shrubs)
 - Absorption of radiation by plant canopy
 - Anthropogenic heat

Domain

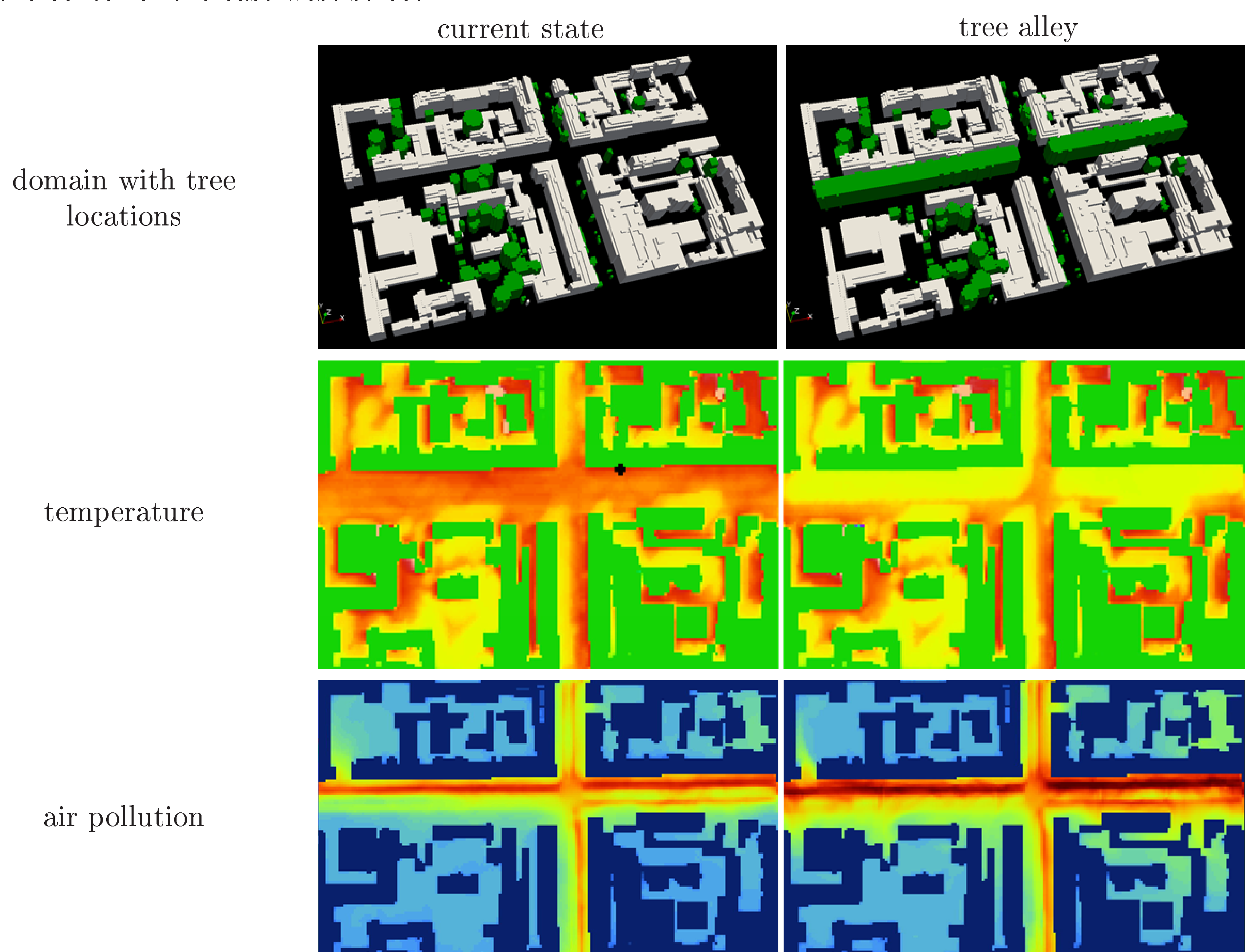
- Area of interest: crossroads in Prague, Czech Republic
- domain sizes: 375 m \times 225 m horizontally, resolution 2 m \times 2 m



Scenario cases

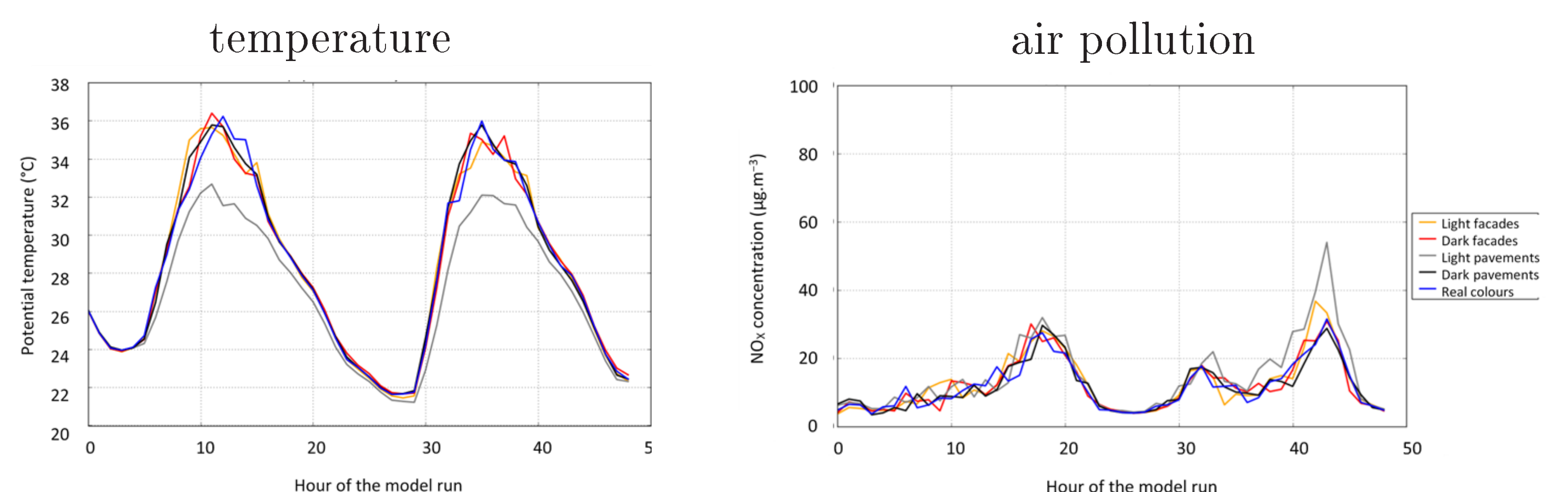
Effect of urban vegetation (tree planting)

We tested different tree planting scenarios, here we present one of them, the effect of tree alley located in the center of the east-west street.



Albedo sensitivity tests

We tested scenarios with different albedo settings of horizontal (walls) and vertical (streets + pavements) surfaces. Here we present the effect of light/dark walls and light/dark vertical surfaces in comparison with the current state.



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Conclusions

We have developed a new urban surface model and incorporated it into PALM. In cooperation with local urban development authority we tested several adaptation urban development strategies in the area of particular crossroads in the city of Prague. Some of the tested scenarios (tree alleys and different urban surfaces) can have significant effects on street temperatures (up to 10 °C lower). At the same time, it can markedly increase the pollutant concentrations in the street. This shows the need for complex assessment in urban planning.