Geophysical Research Abstracts
Vol. 19, EGU2017-18834, 2017
EGU General Assembly 2017

An inter-model comparison of urban canopy effects on climate

Tomas Halenka, Jan Karlicky, Peter Huszar, Michal Belda, and Tatsiana Bardachova
Charles University, Fac. of Mathematics and Physics, Prague, Czech Republic (tomas.halenka@mff.cuni.cz)

The role of cities is increasing and will continue to increase in future, as the population within the urban areas is growing faster, with the estimate for Europe of about 84% living in urban areas in about mid of 21st century. To assess the impact of cities and, in general, urban surfaces on climate, using of modeling approach is well appropriate. Moreover, with higher resolution, urban areas becomes to be better resolved in the regional models and their relatively significant impacts should not be neglected. Model descriptions of urban canopy related meteorological effects can, however, differ largely given the odds in the driving models, the underlying surface models and the urban canopy parameterizations, representing a certain uncertainty.

In this study we try to contribute to the estimation of this uncertainty by performing numerous experiments to assess the urban canopy meteorological forcing over central Europe on climate for the decade 2001-2010, using two driving models (RegCM4 and WRF) in 10 km resolution driven by ERA-Interim reanalyses, three surface schemes (BATS and CLM4.5 for RegCM4 and Noah for WRF) and five urban canopy parameterizations available: one bulk urban scheme, three single layer and a multilayer urban scheme. Actually, in RegCM4 we used our implementation of the Single Layer Urban Canopy Model (SLUCM) in BATS scheme and CLM4.5 option with urban parameterization based on SLUCM concept as well, in WRF we used all the three options, i.e. bulk, SLUCM and more complex and sophisticated Building Environment Parameterization (BEP) connected with Building Energy Model (BEM). As a reference simulations, runs with no urban areas and with no urban parameterizations were performed.

Effects of cities on urban and rural areas were evaluated. Effect of reducing diurnal temperature range in cities (around 2 °C in summer) is noticeable in all simulation, independent to urban parameterization type and model. Also well-known warmer summer city nights appear in all simulations. Further, winter boundary layer increase by 100–200 m, together with wind reduction, is visible in all simulations. The spatial distribution of the night-time temperature response of models to urban canopy forcing is rather similar in each set-up, showing temperature increases up to 3°C in summer. In general, much lower increase are modeled for day-time conditions, which can be even slightly negative due to dominance of shadowing in urban canyons, especially in the morning hours. The winter temperature response, driven mainly by anthropogenic heat (AH) is strong in urban schemes where the building-street energy exchange is more resolved and is smaller, where AH is simply prescribed as additive flux to the sensible heat. Somewhat larger differences between the models are encountered for the response of wind and the height of planetary boundary layer (ZPBL), with dominant increases from a few 10 m up to 250 m depending on the model.

The comparison of observation of diurnal temperature amplitude from ECAD data with model results and hourly data from Prague with model hourly values show improvement when urban effects are considered. Larger spread encountered for wind and turbulence (as ZPBL) should be considered when choices of urban canopy schemes are made, especially in connection with modeling transport of pollutants within/from cities. Another conclusion is that choosing more complex urban schemes does not necessary improves model performance and using simpler and computationally less demanding (e.g. single layer) urban schemes, is often sufficient.