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The long-term changes in summer-time photochemistry due to urban canopy induced meteorological forcing

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Urban surfaces are clearly distinguished from rural ones and represent a specific forcing on meteorological conditions resulting in higher temperatures (urban heat island – UHI), reduced wind speed, enhanced turbulence, reduced humidity etc. It is straightforward to expect that these effects have further impact on the chemistry over these surfaces. This study intends to evaluate the summertime changes in ozone photo-chemistry due to urban canopy meteorological effects using the regional climate model RegCM4 coupled to the CAMx chemistry transport model. Experiments cover the 2001-2010 period focusing on central Europe. In all experiments, emission are kept the same and only the individual elements of meteorological forcing are varied. The most important ones are considered: changes of temperature, horizontal wind and turbulence.

The surface ozone response to the inclusion of urban induced temperature increase is, over urban centers, is rather negative. Decreased wind speeds further contribute to ozone reduction due to suppressed transport of NO_x to the surrounding rural areas, which in turn, increases the titration. The enhanced vertical mixing however have a leading impact on ozone levels: stronger vertical eddy transport removes NO_x from urban environment and thus supports ozone formation. The combined effect of the individual ones is an increase of ozone.

As each of the urban induced meteorological effects (changes of temperature, wind, turbulence) have a clear daily cycle, we examined the daily cycle of the impact on ozone and its precursors as well, and, it is shown that different mechanism become important throughout the day.