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Air-Quality and Urban Forcing in Central Europe

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Recent studies show considerable effect of atmospheric chemistry and aerosols on climate on regional and local scale, especially within the industrial and urban areas. Moreover, there is strong potential of urban environment to affect these processes, especially due to urban heat island. Air-quality climate interactions in urban environment have many aspects. First of all, concentrated emissions lead to considerable abundance of primary and greatly influencing secondary pollutants, affecting not only the local but the regional and global scale. Secondly, the modified concentrations lead to modified radiative forcing leading to temperature changes. Thirdly, as air quality is greatly influenced by the meteorological forcing, urban land-surface represented by many artificial objects changes the meteorology, in turn impacts the air quality as well. This study will focus on this aspect.

Using a regional climate model RegCM4 coupled with Single Layer Urban Canopy Model (SLUCM) and CAMx regional chemical transport model, we will examine the impact of urban meteorological effects on air quality. It is expected that the urban heat island effect introducing higher temperature lead to increased chemical reactions rates changing the photochemistry. Further the surface heterogeneities introducing modified circulation, vertical mixing affect the advection and diffusion of pollutants.

To capture these effects, annual simulations are performed using the RegCM4/SLUCM/CAMx couple for year 2005 for Central European domain in 10 km x 10 km resolution. The surface parameterization uses the SUBBATS option in the model allowing calculation of surface fluxes at much higher resolution – 1 km x 1 km in our case, which is a reasonable resolution to resolve larger cities in Central Europe. Results clearly show urban heat island (UHI) patterns for most the big cities or urbanized areas in the region and sensitivity tests with eliminating urban and suburban land use types provide the estimate of urban parameterization influence.

We find considerable summer impact on concentration of the policy relevant pollutants due to urban land surface effects, especially on ozone formation over urbanized areas that is connected mainly to the urban heat island effect but also to the modified distribution of the primary pollutants due to changed circulation patterns in the urbanized areas.