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How much spatial detail in meteorological parameters is needed to model air-quality in a city? A case study for the city of Antwerp, Belgium.

Hendrik Wouters (1,2), Koen De Ridder (1), Matthias Demuzere (2), Nicole van Lipzig (2), Erwan Brisson (2), Dirk Lauwaet (1), Peter Viaene (1), Felix Deutsch (1), and Nele Veldeman (1)

(1) VITO, Mol, Belgium (hendrik.wouters@vito.be), (2) KU Leuven, Leuven, Belgium (hendrik.wouters@ees.kuleuven.be)

There exists a large discrepancy between the rural and urban land cover in terms of soil water, aerodynamical, thermal and radiative characteristics, and anthropogenic heat. This results in urban-scale meteorological features such as the urban heat island, reduced wind speed and the city breeze. Some of these effects have a considerable impact on human health in cities when the nocturnal cooling is reduced during heat waves or when air quality is affected during smog episodes. The question rises what impact does urban climate have on air quality in cities. The Regional climate model COSMO-CLM updated with the urban parameterization (TERRA_MLU) and the air-quality AURORA (VITO NV, Belgium) are used to quantify and understand the interactions between (urban) climate and air quality on different scales.

COSMO-CLM is currently cascade-nested inside ECMWF 12.5km analysis up to a horizontal resolution of 1km over Antwerp (Belgium). The urban parameterization TERRA_MLU is implemented in COSMO-CLM using a tile approach in which the urban surface can coexist with the natural area in one grid-cell. The inclusion of anthropogenic heat is based on country-specific data of energy consumption downscaled with population density and urbanization. Meteorological model data from COSMO-CLM is used as forcing for the air-quality model AURORA.

Results, in particular the urban heat island effect, are evaluated with urban/rural meteorological measurements in Antwerp, Ghent and Brussels starting from 2012. It is investigated whether air-quality modeling can be improved when forcing AURORA with (urban) microscale meteorological data from COSMO-CLM rather than with coarser meteorological data from ECMWF. Therefore each nesting step of COSMO is subsequently used as input for the air-quality model. In order to set priorities for the improvement of air-quality modelling in the future, the relative importance of orography, urban climate and the impact of uncertainty in pollutent emissions to air-quality modelling are investigated.