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Impact of urban emission on air-quality over central Europe: present day and future emissions perspective

Peter Huszar, Michal Belda, Tomas Halenka, and Jan Karlicky

Charles University in Prague, Fac. of Mathematics and Physics, Dept. of Atmospheric Physics, Prague, Czech Republic (tomas.halenka@mff.cuni.cz)

The purpose of the study is to quantify the impact of present-day and future urban emission from central European cities on the regional air-quality (AQ), based on a modeling couple of the regional climate model RegCM4.2 and the chemistry transport model CAMx, including two-way interactions. A series of simulations was carried out for the present (2001-2010) decade and two future decades (2026-2035 and 2046-2055) either with all urban emissions included (base case) or without considering urban emissions. As we are interested on the impact of emission changes only, the impact of different driving meteorological conditions in the future (due to climate change) are not considered. The emissions used is the TNO MEGAPOLI European emission database that includes country/sector based scenarios for years 2030 and 2050, which were used for the encompassing decades. Further, the sensitivity of ozone production to urban emissions was examined by performing reduction experiments with -20% emission perturbation of NO_x and/or NMVOC. The model was also validated using surface measurements of key pollutants.

Selected air-quality measures were used as metrics describing the cities emission impact on regional air pollution. Due to urban emissions, significant ozone titration occurs over cities while over rural areas further from, ozone production is modeled, mainly in terms of number of exceedances and accumulated exceedances over the threshold of 40 ppbv. Urban NO_x, SO_2 and PM2.5 emissions also significantly contribute to concentrations in the cities themselves (up to 50-70% for NO_x and SO_2 , and up to 55% for PM2.5), but the contribution is large over rural areas as well (10-20%). Although air pollution over cities is largely determined by the local urban emissions, considerable (often a few tens of %) fraction of the concentration is attributable to other sources from rural areas and minor cities. The future urban emission AQ fingerprint is, in general, slightly smaller than in the present. This, however, often means higher final concentrations in case of ozone due to suppressed titration over cities. NO_x pollution as well as the urban contribution to it decreases in future, with a few areas as exception (mainly eastern European countries). In case of secondary inorganic aerosol, decreases are modeled.