Geophysical Research Abstracts
Vol. 17, EGU2015-13833, 2015
EGU General Assembly 2015

On the urban emissions effects on tropospheric chemistry and climate

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The impact of emissions of short lived gases and aerosols from the large cities on the tropospheric chemistry and climate is examined with focus on Central Europe. A coupled modelling system with two way interactions consisting of the regional climate model RegCM4 and the chemistry transport model CAMx was implemented with a 10 km x 10 km resolution over Central Europe domain. For the period of 2001-2010 several experiments were performed: control one with urban emissions removed, one with urban emissions included and another one having these emissions scaled by certain factor. The chemistry-climate impact is evaluated as the difference between the corresponding experiments divided by this factor. This choice was important to obtain statistically significant results. The linearity of the chemical response is examined to justify this approach.

In the radiation calculations, the effects of tropospheric ozone, primary (black and organic carbon) and secondary inorganic aerosols (sulfates and nitrates) are taken into account including the first and second indirect aerosol effects. The results showed significant ozone titration especially over the western and northern part of the domain. City emissions contribute to ozone production over southern Europe. An increase of sulfate, nitrate aerosols and black/organic is significant as well and it is not limited to urbanized areas only. Evaluating the radiative impacts, we found that the total effect on 2 m temperature over central Europe is characterized by small but statistically significant summer cooling up to -0.015 K as the 2001-2010 average. Further the impact on radiative fluxes, precipitation, PBL height and wind speed is presented as well.