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Regional air quality simulations to evaluate three anthropogenic emission inventories over the Eastern Mediterranean

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A good estimate of gas and aerosol anthropogenic emissions is crucial for estimating gases and aerosol concentrations in the atmosphere. Although high-resolution emission inventories covering the entire Europe exist and they have been applied in several studies, their quality has not been evaluated uniformly in all the European regions. Most of these existing studies analyzed mainly the North-Western European countries supported also by a large variety of observations. On the other hand, there are not many studies focusing on Eastern Mediterranean.

In this study we present the results from a set of simulations that aims to quantify the effect of three different anthropogenic emission inventories (EMEP, 0.5˚x0.5˚ degrees; EMEP/INERIS 0.1˚x0.1˚ degrees; TNO/MACC_2005 1/8˚x1/16˚ degrees) on gas and aerosol concentrations over the Eastern Mediterranean region (Turkey and the Balkan Peninsula). These inventories are characterized by similar total emissions, but with different resolutions and geographical distributions. We present the results from regional model simulations (WRF-CMAQ) and we analyze the impact of different grid resolutions (30x30 km and 10x10 km) and emission distributions on model performances. We performed two sets of simulations, one representing winter conditions (1 month simulation for January 2009), and one representing summer conditions (1 month simulation for July 2009).

We used the OMI satellite observations of NO_2 total column concentrations to evaluate the geographical pattern of simulated NO_2 concentrations. The largest observed pollution hot spot is located over Istanbul, with monthly mean averages larger than $12x10^{15}$ molecules cm^{-2} in January and $6x10^{15}$ molecules cm^{-2} in July. Other polluted spots are located over the main cities of the region (e.g. Ankara, Athens, Belgrade and Bucharest). None of the three emission inventories for both model resolutions were able to represent the observed NO_2 total column concentrations. In particular the concentrations over Istanbul are largely underestimated. The model simulations could generally capture the peaks over other cities in the region (e.g. Athens, Belgrade, Bucharest) with significant differences between the emission inventories.

The simulated O_3 and $PM_{2.5}$ monthly mean surface concentrations at 30x30 km resolution are similar among the simulations with EMEP and EMEP/INERIS anthropogenic emissions. The simulation with TNO/MACC_2005 inventory, as compared to EMEP, showed large differences, up to 10 ppbv for O_3 and 5 μg m^{-3} for $PM_{2.5}$, particularly over Turkey. The advantage of using the EMEP/INERIS inventory compared to the standard EMEP inventory is only visible at the finer model resolution (10x10 km) as the spatial distribution of anthropogenic emissions is better linked to the nature of the emissions (especially for the urban areas). The simulation with TNO/MACC_2005 inventory at 10x10 km resolution shows a large number of point sources over Turkey and in the Balkan Peninsula, which are not shown by EMEP/INERIS, with differences up to 8 μg m^{-3} in $PM_{2.5}$ monthly mean surface concentrations.