Geophysical Research Abstracts
Vol. 19, EGU2017-11911, 2017
EGU General Assembly 2017

A statistical downscaling approach for roadside NO_2 concentrations: Application to a WRF-Chem study for Berlin

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Many European cities continue to struggle with meeting the European air quality limits for NO_2. In Berlin, Germany, most of the exceedances in NO_2 recorded at monitoring sites near busy roads can be largely attributed to emissions from traffic. In order to assess the impact of changes in traffic emissions on air quality at policy relevant scales, we combine the regional atmosphere-chemistry transport model WRF-Chem at a resolution of 1kmx1km with a statistical downscaling approach. Here, we build on the recently published study evaluating the performance of a WRF-Chem setup in representing observed urban background NO_2 concentrations from Kuik et al. (2016) and extend this setup by developing and testing an approach to statistically downscale simulated urban background NO_2 concentrations to street level.

The approach uses a multilinear regression model to relate roadside NO_2 concentrations observed with the municipal monitoring network with observed NO_2 concentrations at urban background sites and observed traffic counts. For this, the urban background NO_2 concentrations are decomposed into a long term, a synoptic and a diurnal component using the Kolmogorov-Zurbenko filtering method. We estimate the coefficients of the regression model for five different roadside stations in Berlin representing different street types. In a next step we combine the coefficients with simulated urban background concentrations and observed traffic counts, in order to estimate roadside NO_2 concentrations based on the results obtained with WRF-Chem at the five selected stations. In a third step, we extrapolate the NO_2 concentrations to all major roads in Berlin. The latter is based on available data for Berlin of daily mean traffic counts, diurnal and weekly cycles of traffic as well as simulated urban background NO_2 concentrations.

We evaluate the NO_2 concentrations estimated with this method at street level for Berlin with additional observational data from stationary measurements and mobile measurements conducted during a campaign in summer 2014. The results show that this approach allows us to estimate NO_2 concentrations at roadside reasonably well. The approach can be applied when observations show a strong correlation between roadside NO_2 concentrations and traffic emissions from a single type of road. The method, however, shows weaknesses for intersections where observed NO_2 concentrations are influenced by traffic on several different roads.

We then apply this downscaling approach to estimate the impact of different traffic emission scenarios both on urban background and street level NO_2 concentrations.

References

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