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Validation of a statistical approach to estimate surface ozone for Belgium

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Meteorological conditions are known to have a strong impact on air quality that in turn may profoundly impact human healthy, especially in an urban environment. In the context of a warming climate, the question arises whether one may expect an increase in frequency of observed ozone peak periods, exceeding the information threshold value of 180 μg/m3 . In order to provide a rigorous answer, Chemical Transport Models (CTMs) are best used. Such models simulate the complex physical and chemical reactions in the atmosphere. However, CTMs are very computationally demanding in a climatological context and only a few climatological CTM simulations exist. This lack of available simulations prevents a reliable CTM-based estimation and uncertainty estf-quantification the impact of climate change on air quality. The best alternative approach therefore takes a statistical perspective and consists of the following steps: 1) statistical relations between air pollution concentrations and meteorological drivers are constructed by use of long time series of observed ozone concentrations and meteorological parameters, 2) these statistical relations are validated i.e. they are found to be robust under different time periods and circumstances, 3) the statistical relations are applied to a range of meteorological climate projections and are analyzed to find the impact of climate change on air quality. In this last step, uncertainties can be estimated due to the availability of a wide range of regional climate projections (e.g. CORDEX or CMIP5 data). In this work we have established the first two steps. More specifically, we have extended the approach of Porter et al. (2015) to estimate the probability of extreme ozone concentrations given certain meteorological conditions such as temperature, radiation or stability. Since the relation between ozone and meteorological variables is in general nonlinear ordinary regression methods cannot be used for analyzing extreme ozone behavior but quantile regression is used and the approach is extended to piecewise linear quantile regression. An extensive range of data sets is used for the model validation for different urban, suburban and rural locations in Belgium with hourly meteorological and ozone variables for the period 1990-2012. The meteorological data are thereby taken from climate simulations with the ALARO-SURFEX system driven by realistic conditions (Hamdi et al., 2014). We have verified that this meteorological model data compares well with observations. In a second step, the approach was tested in an independent setting using climate projections using the ALARO-SURFEX system combined with ozone data generated by the CTM CHIMERE (Hamdi et al., 2015). It is found that our approach considerably improves the approach of Porter et al. (2015).

Hamdi et al. (2014), International Journal of Climatology, 34(4), 978-999.

Hamdi et al. (2015), Urban Climate, 12, 160-182.

Porter et al. (2015), Atmospheric Chemistry and Physics, 15(18), 10349-10366.