Geophysical Research Abstracts
Vol. 19, EGU2017-18557, 2017
EGU General Assembly 2017
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High resolution spatio-temporal mapping of NO_2 pollution for estimating personal exposures of the Dutch population

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Air pollution has been associated with adverse health effects (e.g., cardiovascular and respiration diseases) in the urban environments. Therefore, the assessment of people's exposure to air pollution is central in epidemiological studies. The estimation of exposures on an individual level can be done by combining location information across space and over time with spatio-temporal data on air pollution concentrations. When detailed information on peoples' space-time paths (e.g. commuting patterns calculated by means of spatial routing algorithms or tracked through GPS) and peoples' major activity locations (e.g. home location, work location) are available, it is possible to calculate more precise personal exposure levels depending on peoples' individual space-time mobility patterns. This requires air pollution values not only at a high level of spatial accuracy and high temporal granularity but such data also needs to be available on a nation-wide scale. As current data is seriously limited in this respect, we introduce a novel data set of NO_2 levels across the Netherlands. The provided NO_2 concentrations are accessible on hourly timestamps on a 5 meter grid cell resolution for weekdays and weekends, and each month of the year. We modeled a single Land Use Regression model using a five year average of NO_2 data from the Dutch NO_2 measurement network consisting of N=46 sampling locations distributed over the country. Predictor variables for this model were selected in a data-driven manner using an Elastic Net and Best Subset Selection procedure from 70 candidate predictors including traffic, industry, infrastructure and population-based variables. Subsequently, to model NO_2 for each time scale (hour, week, month), the LUR coefficients were fitted using the NO_2 data, aggregated per time scale. Model validation was grounded on independent data collected in an ad hoc measurement campaign. Our results show a considerable difference in urban concentrations between weekdays and weekend-days. We observe a diurnal variation in concentrations particularly during weekdays related to traffic intensity and considerable differences in concentrations between seasons. Considerable spatial variation occurs both within cities and urban areas where concentrations on roads are high and decrease rapidly with distance to roads. Both on-road and far-from-road concentrations are consistently higher in urban areas than in rural areas.