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The spatio-temporal covariation in combustion related air pollutants in the Netherlands

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Air pollution is estimated to cause 2 million premature deaths per year worldwide (WHO). Combustion fumes, e.g. from traffic, domestic use and industry, form a large part of air pollution. In order to relate air pollution to health, many studies examine and model the spatial and temporal patterns in pollution levels, often using land use regression (LUR) models. Epidemiologists can then combine these models with human activity patterns to assess personal exposures. However, most of these studies focus either on the temporal or the spatial domain, but many pollutants show large variability in both space and time. For instance, in personal exposure assessment, using a static model would not allow incorporating higher pollution levels during commute hours. Also, most studies focus on an individual air pollutant, for instance O_3, NO_2 or NO. However, these pollutants have a strong interaction due to photochemical processes. In the urban environment, O_3 near roads is scavenged by NO to form NO_2 and O_2. Further away from the sources, O_3 can form and raise background concentrations. Due to these interactions, it is recommended to assess these pollutants in a combined study. In this study, we address both issues by temporal land use regression modelling of O_3, NO_2 and NO, and studying the co-variability of these pollutants and the relations with typical weather conditions over the year. We use hourly concentrations from the measurement network of the Dutch National Institute for Public Health and the Environment, and aggregate them by hour, month and weekdays/weekends. This enables us to calculate coefficients per mentioned time steps. 70 candidate predictors that are known to have a strong relationship with combustion related emissions are used in the LUR modelling process. For all pollutants, the optimal LUR was achieved with 4 predictors. With the predictors set, the temporal variability was determined by calculating the coefficients per hour, per weekday or weekend day, and per month, enabling us to give spatially and temporally detailed description of the space-time pattern in air pollution levels over the whole of the Netherlands. Our LURs for O_3, NO_2, and NO strongly reflect the photochemical processes in both space and time. O_3 shows a high background value throughout the day and only dips in the (close) vicinity of roads. The rate of decrease is determined by traffic intensity. NO_2 and NO show a low background value, but values rise abruptly in the vicinity of roads. Also, background values are significantly lower in urban areas than in rural areas. The NO_2 LUR is validated against NO_2 measurements from the Traffic Related Air pollution and Children's respiratory HEalth and Allergies (TRACHEA) study, returning an R2 of 0.61.