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Evaluating methods for estimating space-time paths of individuals in calculating long-term personal exposure to air pollution

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Air pollution is one of the major concerns for human health. Associations between air pollution and health are often calculated using long-term (i.e. years to decades) information on personal exposure for each individual in a cohort. Personal exposure is the air pollution aggregated along the space-time path visited by an individual. As air pollution may vary considerably in space and time, for instance due to motorised traffic, the estimation of the spatio-temporal location of a persons' space-time path is important to identify the personal exposure. However, long term exposure is mostly calculated using the air pollution concentration at the x, y location of someone's home which does not consider that individuals are mobile (commuting, recreation, relocation). This assumption is often made as it is a major challenge to estimate space-time paths for all individuals in large cohorts, mostly because limited information on mobility of individuals is available.

We address this issue by evaluating multiple approaches for the calculation of space-time paths, thereby estimating the personal exposure along these space-time paths with hyper resolution air pollution maps at national scale. This allows us to evaluate the effect of the space-time path and resulting personal exposure. Air pollution (e.g. NO_2, PM_{10}) was mapped for the entire Netherlands at a resolution of $5 \times 5\,m^2$ using the land use regression models developed in the European Study of Cohorts for Air Pollution Effects (ESCAPE, http://escapeproject.eu/) and the open source software PCRaster (http://www.pcraster.eu). The models use predictor variables like population density, land use, and traffic related data sets, and are able to model spatial variation and within-city variability of annual average concentration values. We approximated space-time paths for all individuals in a cohort using various aggregations, including those representing space-time paths as the outline of a persons' home or associated parcel of land, the 4 digit postal code area or neighbourhood of a persons' home, circular areas around the home, and spatial probability distributions of space-time paths during commuting. Personal exposure was estimated by averaging concentrations over these space-time paths, for each individual in a cohort. Preliminary results show considerable differences of a persons' exposure using these various approaches of space-time path aggregation, presumably because air pollution shows large variation over short distances.