Monthly NO_2 exposure models for the United States using satellite-derived measurements, 2000 - 2010

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Background: Land use regression (LUR) is widely used for estimating within-urban variability in air pollution, typically at the urban level and for long-term averages. LUR techniques have recently been extended to national and continental scales.

Aims: Our aim is a LUR for NO_2 in the continental US that provides the excellent spatial resolution found in most LURs (~100-m scale), incorporates satellite estimates, covers 100% of US Census Blocks, and provides monthly average concentrations for one decade.

Methods: Our work extends a previously-published national LUR for year-2006 in the US. We employ eleven years (2000-2010) of hourly NO_2 measurements from US EPA monitors to calculate monthly scaling factors, which account for deviations relative to the reference year. We then create a spatially-varying (inverse-distance weighted) temporal "scaling surface" for each month, to estimate monthly concentration deviations at non-measurement locations.

Results: The resulting model captures 76% of the spatial variability and 73% of the temporal variability (population-weighted average) with low average bias (22%). Model performance is best at locations near monitors (e.g., spatial R^2 = 0.79, mean bias 12% for locations within 25 km of a monitor). Urban and suburban locations perform moderately better than rural locations at predicting spatial (R^2: 0.65 , 0.71, and 0.60, respectively) and temporal (R^2: 0.69, 0.70, 0.55) variability and significantly better at predicting absolute concentrations (mean bias: 19%, 10%, 60%).

Conclusions: Our approach reliably estimates monthly outdoor NO_2 concentration at a spatial resolution capable of capturing within-urban and near-roadway variability in concentrations. We apply this technique to the ~8 million U.S. Census blocks in the contiguous United State to provide a decade (2000 - 2010) of high-resolution monthly NO_2 concentration estimates; these data are publicly available.