**Additional file 1** Analysis of NO2 monitor data

63,865 daily mean NO2 concentrations for the period 2009-2013 were available from 46 urban and 1 suburban background sites within the confines of the M25 road network around London. The data were obtained from Air Quality England;[1] and the London Air Quality Network,[2] which included data from the Automatic Urban and Rural Network (AURN).[3] Analyses were conducted in STATA version 12,[4] and in R version 3.2.0,[5] using the packages geoR,[6] plyr,[7] Hmisc,[8]and nlme.[9]

The mean and variance of the 47 site-specific 5-year means was 36.52 µg/m3 and 76.200 (µg/m3)2 respectively; the average within site variance of daily mean NO2 concentrations was 274.61 (µg/m3)2; and we estimated the average variance of the within site means as 0.237 (µg/m3)2.

**Temporal variation**

We assumed that the variation in mean daily NO2 measurements was made up of two components, temporal variation in “true” daily mean NO2 concentrations plus instrument error. To estimate these components, we calculated the Pearson correlations (over-time between each pair of sites, . The correlations were then plotted against the Euclidean distances between paired sites and a weighted linear regression model fitted of correlation by distance (in km). [10-11]



**Fig**. 1.1 Weighted linear regression line fitted to a scatter plot of correlation coefficients by distance.

The fitted linear regression equation was:

Where:

is the Euclidean distance between sites with co-ordinates ( (i.e. )

By extrapolating the regression line back to the origin we estimated the variance-covariance at sites as:

**Spatial variation**

We further assumed that the spatial variation in the 47 site-specific 5-year means () was made up of a systematic component and a random component that included measurement error (due to imprecision in the estimation of site-specific 5-year means). To estimate these components we used REML in R to simultaneously fit a) a simple second order polynomial in the easting and northing site co-ordinates to the 5-year means and b) a model with exponential covariance structure to the empirical semivariogram of the residuals (Figure A2). The variables to include in part (a) were chosen based on preliminary model fitting in STATA and AIC criteria. The constant term of the exponential model (i.e. the nugget which is the semivariance when distance=0) represents the measurement error and we forced this to equal our estimate of the average within-site variance of the 5-year measured mean NO2 concentrations i.e. 0.237 (µg/m3)2.



**Fig.** 1.2 Exponential covariance model fitted to an empirical semivariogram of the residuals. Distance is in km.

Constraining the overall variance of site-specific means to equal 76.200 (µg/m3)2, the fitted model can be expressed as follows:-

++ measurement error

Where:

;

**Constructing the “true” data (**

Removing measurement error and combining both spatial and temporal components we estimate the “true” daily mean NO2 concentrations ( for each site ) and each day as follows:

+ +

Where:

;

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