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**E-Table 1:** Baseline disease rates (c3) and concentration response functions for short-term () and long-term exposure used in our simulations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Disease**  **Outcome** | **Baseline rate per LSOA per day** | **Pollutant** | **Concentration response function per 1 µg/m3** | |
| **Short-term exposure** | **Long-term exposure** |
| All-cause Mortality | 0.0264a | NO2 | 0.000707b | 0.00402c |
| O3 | 0.000090d | -0.00204e |
| Cardiovascular hospital admissions | 0.0835f | NO2 | 0.000419b | 0.00583g |
| O3 | 0.000539d | -0.00207hi |

a Average death rate per LSOA per day in London in 2011 estimated using data from the Office for National Statistics[1,2]; b Mills et al, 2015[3]; c Faustini et al, 2014[4]; d Katsouyanni et al, 2009[5]; e Atkinson et al, 2016[6]; f Number of hospital admissions per LSOA per day for the financial year 2011-2012 estimated using data from the Office for National Statistics,[1] and NHS Digital[7]; g Katsoulis et al, 2014[8]; h Halonen et al 2016 [9]; i Based on the population-weighted average of two age-specific concentration response function using age-specific population data for London 2011 from the Office for National Statistics [10].

Estimating the Pearson correlation coefficients and variance ratios used to define our simulation scenario.

For each pollutant, site-type and pollution model, the validation data provided us with daily mean monitor measurements ( linked to their corresponding model predictions (. We estimated the spatial variance and temporal variance (of “true” data (i.e. excluding instrument error) based on an analysis of the monitor measurements, as described in detail in the supplementary material of our previous paper.[11] We then estimated, as follows:

Where represents the average within-site variance of the daily modelled pollutant data and the average within-site covariance between daily modelled and measured pollutant data.

**E-Table 2** Cardiovascular hospital admissions and NO2 (measurement error: additive):

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pollutant** | **Model** | **Estimating the health effect of short-term exposure** | | | | **Estimating the health effect of long-term exposure** | | | |
|  | **Bias a**  **(%)** | **Coverage probability**  **(%)** | **Power**  **(%)** |  | **Bias a**  **(%)** | **Coverage Probability**  **(%)** | **Power**  **(%)** |
| NO2  (Urban / Suburban) | Land Use Regression  (LUR) | 0.00267  (0.00102) | -36.3 | 68.8 | 73.6 | 0.0072  (0.0106) | -87.7 | 0.7 | 11.0 |
| Dispersion | 0.00357  (0.00115) | -14.8 | 90.2 | 86.9 | 0.0400  (0.0254) | -31.4 | 87.7 | 36.2 |
| Hybrid1 | 0.00346  (0.00112) | -17.4 | 88.8 | 86.1 | 0.0167  (0.0153) | -71.4 | 23.7 | 20.4 |
| Hybrid2 | 0.00452  (0.00138) | **7.9** | 93.9 | 89.1 | 0.0472  (0.0279) | -19.0 | 92.5 | 40.5 |
| NO2  (Roadside / Kerbside) | Land Use Regression  (LUR) | 0.00188  (0.00068) | -55.1 | 8.8 | 78.5 | 0.0051  (0.0066) | -91.3 | 0.0 | 12.4 |
| Dispersion | 0.00333  (0.00073) | -20.5 | 78.3 | 99.7 | 0.0584  (0.0137) | **0.2b** | 94.4 | 99.1 |
| Hybrid1 | 0.00274  (0.00067) | -34.6 | 40.9 | 98.2 | 0.0139  (0.0080) | -76.2 | 0.0 | 41.0 |
| Hybrid2 | 0.00397  (0.00089) | -5.3 | 94.5 | 99.6 | 0.0641  (0.0140) | **9.9** | 92.1 | 99.7 |

a Percent bias is highlighted in bold when positive (i.e. away from the null) rather than negative (i.e. towards the null); b Bias not statistically significant at the 5% level (p>0.05) based on a simple one sample t-test.

**E-Table 3** Cardiovascular hospital admissions and NO2 (measurement error: proportional):

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pollutant | Model | Estimating the health effect of short-term exposure | | | | Estimating the health effect of long-term exposure | | | |
|  | Bias a  (%) | Coverage probability  (%) | Power  (%) |  | Bias a  (%) | Coverage Probability  (%) | Power  (%) |
| NO2  (Urban / Suburban)c | Land Use Regression  (LUR) | 0.00320  (0.00103) | -23.6 | 82.7 | 86.5 | 0.0079  (0.0117) | -86.4 | 1.2 | 10.1 |
| Dispersion | 0.00349  (0.00097) | -16.7 | 88.4 | 94.4 | 0.0368  (0.0259) | -36.9 | 86.3 | 32.1 |
| Hybrid1 | 0.00344  (0.00096) | -17.9 | 87.0 | 95.0 | 0.0140  (0.0152) | -76.0 | 17.4 | 16.1 |
| Hybrid2 | 0.00464  (0.00121) | **10.7** | 92.7 | 96.7 | 0.0472  (0.0297) | -19.0 | 93.4 | 36.1 |
| NO2  (Roadside / Kerbside)c | Land Use Regression  (LUR) | 0.00251  (0.00083) | -40.1 | 44.1 | 87.4 | 0.0066  (0.0085) | -88.7 | 0.0 | 13.2 |
| Dispersion | 0.00323  (0.00070) | -22.9 | 71.8 | 99.7 | 0.0480  (0.0168) | -17.7 | 88.6 | 79.1 |
| Hybrid1 | 0.00271  (0.00064) | -35.3 | 34.2 | 99.1 | 0.0146  (0.0100) | -75.0 | 0.9 | 30.8 |
| Hybrid2 | 0.00399  (0.00085) | -4.8 | 95.3 | 99.6 | 0.0575  (0.0181) | -1.4b | 93.7 | 87.0 |

a Percent bias is highlighted in bold when positive (i.e. away from the null) rather than negative (i.e. towards the null); b Bias not statistically significant at the 5% level (p>0.05) based on a simple 1 sample t-test; c We simulate logged true and model data but use the untransformed data for modelling.

**E-Table 4** Cardiovascular hospital admissions and O3 (measurement error: additive):

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pollutant | Model | Estimating the health effect of short-term exposure | | | | Estimating the health effect of long-term exposure | | | |
|  | Bias a  (%) | Coverage probability  (%) | Power  (%) |  | Bias a  (%) | Coverage Probability  (%) | Power  (%) |
| O3  (Urban / Suburban) | Land Use Regression  (LUR) | 0.00577  (0.00124) | **7.1** | 93.9 | 99.6 | -0.0004  (0.0234) | -98.1 | 83.0 | 7.1 |
| Dispersion | 0.00457  (0.00105) | -15.2 | 89.0 | 98.8 | -0.0106  (0.0294) | -48.8 | 88.5 | 10.6 |
| Hybrid1 | 0.00555  (0.00110) | **3.0** | 93.6 | 99.9 | -0.0025  (0.0261) | -87.9 | 88.1 | 7.7 |
| Hybrid2 | 0.00573  (0.00115) | **6.3** | 95.1 | 99.9 | -0.0156  (0.0347) | -24.6 | 90.2 | 12.0 |
| O3  (Roadside / Kerbside) | Land Use Regression  (LUR) | 0.00404  (0.00121) | -25.0 | 79.7 | 92.1 | -0.0057  (0.0207) | -72.5 | 87.5 | 5.0 |
| Dispersion | 0.00392  (0.00110) | -27.3 | 72.5 | 94.9 | -0.0191  (0.0291) | -7.7b | 93.0 | 11.6 |
| Hybrid1c |  |  |  |  |  |  |  |  |
| Hybrid2 | 0.00491  (0.00128) | -8.9 | 93.4 | 96.9 | -0.0200  (0.0309) | -3.4b | 93.3 | 11.0 |

a Percent bias is highlighted in bold when positive (i.e. away from the null) rather than negative (i.e. towards the null); b Bias not statistically significant at the 5% level (p>0.05) based on a simple 1 sample t-test; cThe model provided particularly poor predictions for one monitoring site, which caused convergence problems in our simulation program

**Checks on simulations**

The ability of our simulation programs to produce “true” and pseudo-modelled data with given correlations and variance ratios both spatially and temporally was assessed by including checks within our simulation program for roadside / kerbside NO2 (additive error).

Overall the correlations and variance ratios, when averaged across simulations for roadside / kerbside NO2 (additive error) were consistent with their target values (E-Table 5). There was a slight positive bias in the spatial variance ratio but this was negligible (<0.4%).

**E-Table 5:** Checks on correlations and variance ratios incorporated in pseudo-modelled roadside / kerbside NO2 data.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Temporal / Spatial | True / model | Variance | | Variance Ratio | | Correlation Coefficient | |
| Simulateda | Specified | Simulatedb | Specified | Simulatedc | Specified |
| Temporal | True | 359.0 | 359.1262 | 1 | 1 | 1 | 1 |
| LUR | 625.2 |  | 1.743 | 1.741 | 0.586 | 0.586 |
| Dispersion | 551.1 |  | 1.535 | 1.535 | 0.975 | 0.975 |
| Hybrid1 | 648.1 |  | 1.806 | 1.805 | 0.871 | 0.871 |
| Hybrid2 | 370.2 |  | 1.031 | 1.031 | 0.953 | 0.953 |
| Spatial | True | 653.4 | 654.5549 | 1 | 1 | 1 | 1 |
| LUR | 2337 |  | 3.593 | 3.580 | 0.168 | 0.168 |
| Dispersion | 506.9 |  | 0.777 | 0.777 | 0.887 | 0.887 |
| Hybrid1 | 1551 |  | 2.383 | 2.374 | 0.364 | 0.365 |
| Hybrid2 | 490.9 |  | 0.752 | 0.751 | 0.961 | 0.961 |

a Average within-simulation variance. b Average within-simulation variance ratio. c Average within-simulation correlation.

LUR: Land Use Regression. Hybrid 1: LUR with dispersion output spline as a covariate. Hybrid 2: generalised additive model (GAM) combining splines in LUR and dispersion outputs.

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