

ADMS-Urban and ADMS-Roads Validation

Validation of ADMS-Urban and ADMS-Roads Against M4 and M25 Motorway Data

1. Introduction

Monitoring data from the M4 and the M25 have been used as part of a validation exercise for ADMS-Urban and ADMS-Roads. Monitored concentrations of NO_x, NO₂ and PM₁₀ from the M4 during 1997, and monitored concentrations of NO_x and NO₂ from the M25 during 1996 have been used.

Three sets of concentrations have been generated. The first set uses ADMS-Urban, modelling the relevant section of the M4 or M25, with a grid of emissions, stretching out 5km in each direction from the roadside monitors. The background concentrations of NO_x and O₃ in these runs are from Harwell, background PM₁₀ for the M4 run has been taken from Rochester, in the absence of any data from Harwell during 1996.

The second set uses ADMS-Urban, modelling the same emissions, but with different background concentrations. The annual average background concentrations at the background monitoring sites, and the background concentrations at each edge of the emissions grids has been found using the 1996 background concentrations given on the NETCEN website, (<http://www.aeat.co.uk/netcen/airqual>). The original background monitoring data have then been multiplied by the ratio of the concentration at the background monitoring site to the average of the four concentrations around the emissions grid. This process has been carried out for NO_x, NO₂ and PM₁₀. The background concentrations of ozone have been decreased by the increase in NO₂ concentration, preserving the initial capability of NO₂ production.

The third set uses ADMS-Roads, modelling just the road in each case, without any grid emissions. The background concentrations have also been multiplied by a factor, but in this case it is the ratio of the annual average concentrations at the background monitoring sites to the annual average background concentrations at the roadside monitors. The factors used to calculate the adjusted background concentrations in sets two and three are given in Table 6, with annual average figures given in Tables 7 and 8. Tables 1 to 5 show the statistics of the calculated concentrations of each pollutant at each monitor. Figures 1 to 5 show time series plots of the calculated and monitored concentrations for the ADMS-Roads results.

Only hours for which the roadside monitoring data, the meteorological data and the background monitoring data are valid have been included in the statistics. The statistics have been calculated using the BOOT package developed by Hanna et al¹.

¹ Hanna S R, Strimaitis D G and Chang J C. (1991), *Hazard Response Modeling Uncertainty (A Quantitative Method)*, Sigma Res. Corp. Report

The following statistics are calculated:

Mean

Sigma: Standard deviation.

Bias: Mean residual = $-\bar{C}_p + \bar{C}_o$

nmse: Normalised mean square error = mean square error / $(\bar{C}_o \bar{C}_p)$

cor: Correlation.

fa2: Fraction of predictions within a factor of two of observations.

fb: Normalised bias as used by EPA. $fb = (\bar{C}_o - \bar{C}_p) / (0.5(\bar{C}_o + \bar{C}_p))$

fs: Normalised sigma as used by EPA. $fs = (\sigma_o - \sigma_p) / (0.5(\sigma_o + \sigma_p))$

Where \bar{C}_o is the average observed concentration and \bar{C}_p is the average calculated concentration.

Table 1a M4 NOx (ppb) statistics (3446 observations)

Model	mean	sigma	bias	nmse	cor	fa2	fb	fs
Observed	130.7	109.6	0	0	1	1	0	0
ADMS-Urban with Harwell background	109.0	134.7	21.66	0.95	0.581	0.521	0.181	-0.205
ADMS-Urban with adjusted background	112.9	135.5	17.79	0.9	0.585	0.55	0.146	-0.211
ADMS-Roads with adjusted background	114.4	133.2	16.23	0.84	0.596	0.585	0.132	-0.194

Table 1b M4 NOx (ppb) percentiles (3446 observations)

Model	99.8 th percentile	99 th percentile	98 th percentile
Observed	574	488	424
ADMS-Urban with Harwell background	846	673	547
ADMS-Urban with adjusted background	863	675	557
ADMS-Roads with adjusted background	847	671	536

Table 2a M4 NO₂ (ppb) statistics (3446 observations)

Model	mean	sigma	bias	nmse	cor	fa2	fb	fs
Observed	24.4	11.78	0	0	1	1	0	0
ADMS-Urban with Harwell background	23.42	16.29	0.98	0.53	0.272	0.599	0.041	-0.322
ADMS-Urban with adjusted background	24.69	16.02	-0.29	0.48	0.277	0.619	-0.012	-0.305
ADMS-Roads with adjusted background	21.66	15.23	2.74	0.53	0.275	0.615	0.119	-0.256

Table 2b M4 NO₂ (ppb) percentiles (3446 observations)

Model	99.8 th percentile	99 th percentile	98 th percentile
Observed	70	58	53
ADMS-Urban with Harwell background	83	70	64
ADMS-Urban with adjusted background	83	71	64
ADMS-Roads with adjusted background	80	68	62

Table 3a M4 PM₁₀ (µg/m³) statistics (4298 observations)

Model	mean	sigma	bias	nmse	cor	fa2	fb	fs
Observed	25.01	14.14	0	0	1	1	0	0
ADMS-Urban with Harwell background	28.5	16.29	-3.49	0.34	0.504	0.799	-0.13	-0.141
ADMS-Urban with adjusted background	27.23	15.76	-2.22	0.34	0.499	0.804	-0.085	-0.108
ADMS-Roads with adjusted background	26.12	15.15	-1.11	0.34	0.493	0.802	-0.043	-0.069

Table 3b M4 PM₁₀ (µg/m³) percentiles (4298 observations)

Model	99.8 th percentile	99 th percentile	98 th percentile
Observed	85	70	63
ADMS-Urban with Harwell background	104	83	74
ADMS-Urban with adjusted background	99	80	72
ADMS-Roads with adjusted background	92	77	69

Table 4a M25 NO_x (ppb) statistics (7024 observations)

Model	mean	sigma	bias	nmse	cor	fa2	fb	fs
Observed	209.36	169.44	0	0	1	1	0	0
ADMS-Urban with Harwell background	162.21	180.37	47.16	1.6	0.15	0.278	0.254	-0.062
ADMS-Urban with adjusted background	177.08	185.16	32.29	1.41	0.186	0.293	0.167	-0.089
ADMS-Roads with adjusted background	161.89	164.84	47.47	1.46	0.154	0.291	0.256	0.028

Table 4b M25 NO_x (ppb) percentiles (7024 observations)

Model	99.8 th percentile	99 th percentile	98 th percentile
Observed	784	632	589
ADMS-Urban with Harwell background	1091	891	759
ADMS-Urban with adjusted background	1143	925	788
ADMS-Roads with adjusted background	936	794	679

Table 5a M25 NO₂ (ppb) statistics (7024 observations)

Model	mean	sigma	bias	nmse	cor	fa2	fb	fs
Observed	30.78	17.16	0	0	1	1	0	0
ADMS-Urban with Harwell background	32.35	15.73	-1.57	0.43	0.213	0.667	-0.05	0.087
ADMS-Urban with adjusted background	34.04	14.93	-3.27	0.38	0.263	0.706	0.101	0.139
ADMS-Roads with adjusted background	28.61	15.13	2.17	0.43	0.281	0.717	0.073	0.126

Table 5b M25 NO₂ (ppb) percentiles (7024 observations)

Model	99.8 th percentile	99 th percentile	98 th percentile
Observed	105	88	78
ADMS-Urban with Harwell background	91	77	70
ADMS-Urban with adjusted background	92	78	71
ADMS-Roads with adjusted background	83	71	65

Table 6 Background factors

	NO _x	NO ₂	PM ₁₀
M4 with ADMS-Urban	1.30	1.27	0.9375
M4 with ADMS-Roads	1.74	1.31	0.9167
M25 with ADMS-Urban	1.96	1.52	N/A
M25 with ADMS-Roads	2.21	1.69	N/A

Table 7 Annual average background for 1997 M4 runs (3446/4298 valid lines only)

	NO _x (ppb)	NO ₂ (ppb)	O ₃ (ppb)	PM ₁₀ (µg/m ³)
Standard Harwell (Rochester for PM ₁₀)	12.8	9.5	28.4	20.3
M4 with ADMS-Urban	16.6	11.5	26.4	19.0
M4 with ADMS-Roads	22.2	11.8	26.1	18.6

Table 8 Annual average background for 1996 M25 runs (7024 valid lines only)

	NO _x (ppb)	NO ₂ (ppb)	O ₃ (ppb)
Standard Harwell	15.5	11.1	22.2
M25 with ADMS-Urban	30.4	14.9	18.5
M25 with ADMS-Urban	34.2	15.9	17.6

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Figure 1

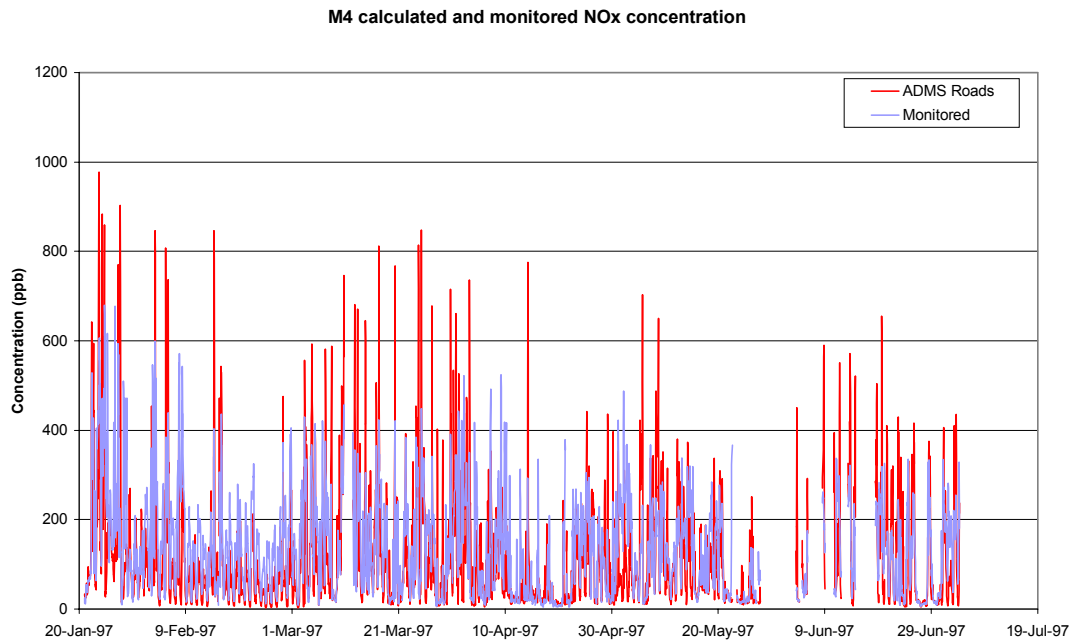


Figure 2

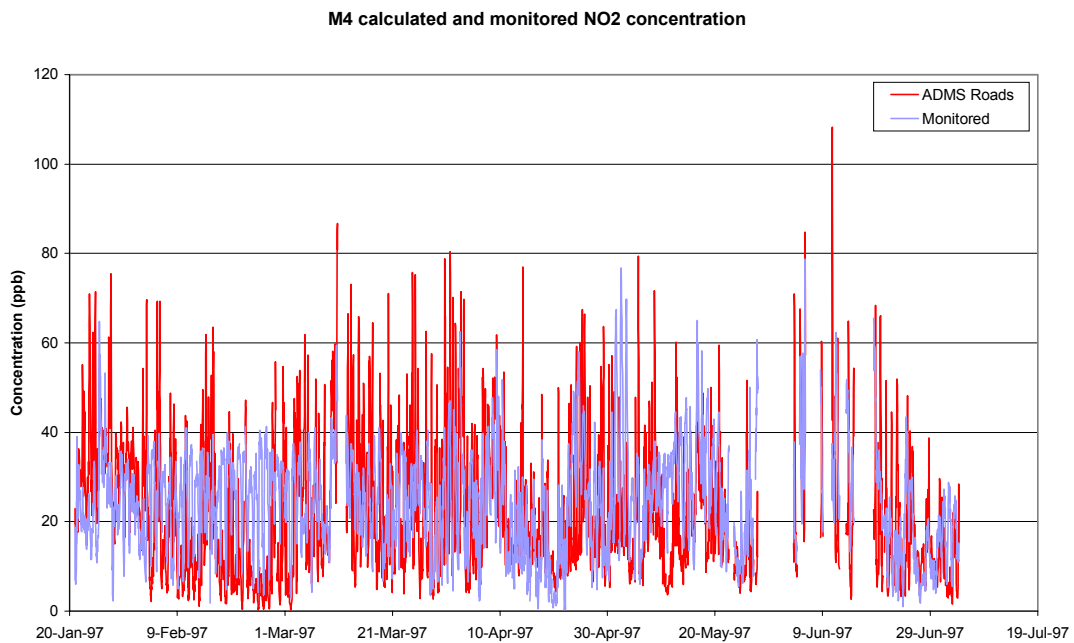


Figure 3

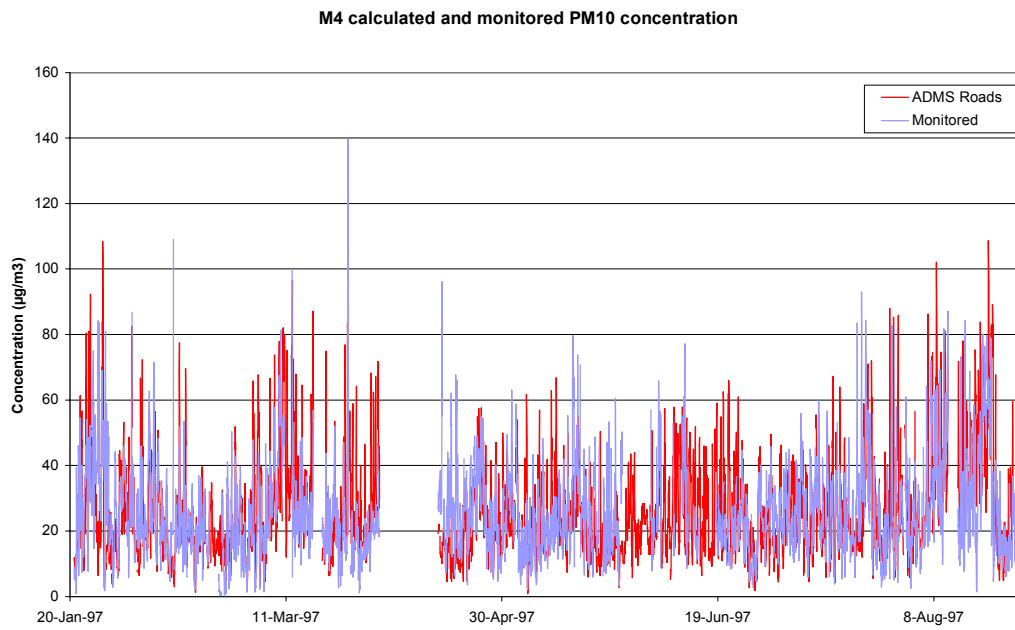


Figure 4

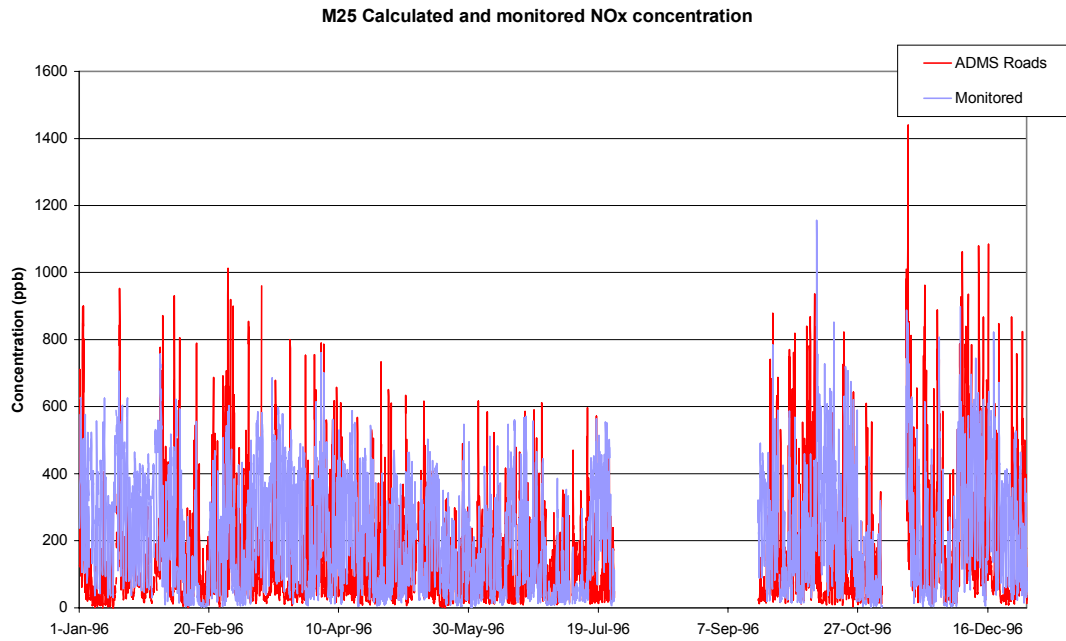


Figure 5

