Cambridge Environmental Research Consultants

Sensitivity Studies of Concentrations of
NO_2 and O_3 for London for 2010 and 2020
Using ADMS-Urban

Prepared for
DEFRA, National Assembly for Wales, The Scottish Executive, and the
Department of the Environment, Northern Ireland

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Summary

Air quality modelling of London has been carried out by Cambridge Environmental Research Consultants (CERC) for the Department of Environment, Food and Rural Affairs (DEFRA) and devolved administrations (DA) as part of the project 'Dispersion Modelling of Air Pollution in Urban Areas in the UK (Phase 2)'. The report *Modelling of Current and Future Concentrations of PM, NO_x and O_3 in London using ADMS-Urban,* 31st August 2006, describes the input data, model set-up and verification and includes predicted concentrations for 2010 and 2020.

This report describes further modelling that has been carried out to investigate the sensitivity of the modelled concentrations to changes in background ozone concentrations, primary NO_2 emissions and the base year considered. The following tests have been carried out:
- Modified background ozone;
- Additional ozone background;
- Changes in primary NO_2 emissions; and
- Change of base year from 2001 to 2003.

A modified algorithm for background O_3 projections results in only modest changes to the O_3 background. In London both the NO_2 and O_3 climates show marginal improvements. Increasing the background O_3 concentration results in significant worsening of both NO_2 and O_3 climates. In 2020 with a $20\mu gm^{-3}$ increase in background O_3, over 95% of the London area is predicted to experience more than 10 exceedences of $100\mu gm^{-3}$ by the 8-hour daily maximum.

Primary NO_2 emissions were increased from the base case (10%) to 15%, typical of conditions in 2003, and to 20%, typical of projections for 2010. These changes significantly impact on NO_2 concentrations, both the annual mean and hourly mean. In 2010 with 20% primary NO_2 emission exceedences of the hourly standard are likely to occur at the busiest roads. Increased primary NO_2 emissions cause a relatively small increase in levels of O_3.

In 2003 high temperatures across Europe resulted in elevated background O_3 levels. The impacts of these causes a significant worsening of both NO_2 and O_3 concentrations in London with widespread exceedence of the standards for annual average NO_2 and 8-hourly O_3 maxima; exceedences of the NO_2 hourly standard are also predicted at roadside both in 2010 and 2020.

Contents

1.   Introduction

This document describes part of the work carried out by Cambridge Environmental Research Consultants (CERC) for the Department of Environment, Food and Rural Affairs (DEFRA) and devolved administrations (DA) for the project 'Dispersion Modelling of Air Pollution in Urban Areas in the UK (Phase 2)'.

As part of the project CERC has used ADMS-Urban[1] to carry out modelling for London to assess air quality in future years, and this is described in the report *Modelling of Current and Future Concentrations of PM, NO_x and O_3 in London using ADMS-Urban,* 31st August 2006. Further modelling has been carried out to investigate the sensitivity of the modelled concentrations to changes in background ozone concentrations, primary NO_2 emissions and the base year considered.

Section 2 presents the air quality standards considered in this study. The investigation into modified background ozone concentrations is presented in Section 3, and Section 4 describes the effect of changing primary NO_2 emissions in future years. Section 5 gives a comparison of calculated concentrations using base years of 2001 and 2003 and Section 6 gives a discussion of the results of the modelling.

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[1] Carruthers DJ, Edmunds HA, Lester AE, McHugh CA, and Singles RJ (1998) Use and Validation of ADMS-Urban in contrasting Urban and Industrial Locations. *International Journal of Environment and Pollution (Volume 14, Nos. 1-6, 2000).*

2.   Air quality standards

Modelling has been carried out to compare predicted concentrations with the UK Air Quality Strategy objectives for NO_2 and PM_{10}, given in Table 2.1.

Table 2.1: AQS Objectives

Substance	Limit value	Reference period and allowed exceedences	Year to be met
NO₂	$200\mu g/m^3$	hourly mean not to be exceeded more than 18 times a year (modelled as 99.79[th] percentile)	2005
	$40\mu g/m^3$	annual mean	2005
PM₁₀	$40\mu g/m^3$	annual mean	2004
	$50\mu g/m^3$	24-hour mean not to be exceeded more than 35 times a year (modelled as 90.41[st] percentile)	2004
	$23\mu g/m^3*$	annual mean	2010
	$50\mu g/m^3*$	24-hour mean not to be exceeded more than 7 times a year (modelled as 98.08[th] percentile)	2010

* provisional objective

For $PM_{2.5}$, the Air Quality Strategy consultation document has proposed an annual average 'cap' of $25\mu g/m^3$ and a reduction in concentrations of 15% between 2010 and 2020, and these have been considered in the modelling.

Table 2.2 shows the ozone objectives taken into account in the modelling.

Table 2.2: Ozone objectives

Substance	Limit value	Reference period and allowed exceedences	Year to be met
O₃	$100\mu g/m^3$	AQS objective Daily maximum 8-hour mean not to be exceeded more than 10 times a year	2005
	$120\mu g/m^3$	EU target value Daily maximum 8-hour mean not to be exceeded more than 20 times a year	2005

3. Background ozone

The base modelling was carried out using meteorological data from Heathrow for 2001. For this modelling, hourly average background ozone concentrations were obtained for 2001 from one of four rural monitoring sites around London, data taken from the upwind site for each hour. These were projected forwards to 2010 and 2020 by assuming the total oxidant $(NO_2 + O_3)$ is unchanged except that due to primary emissions of NO_x estimated as 10%. Two tests have been carried out to investigate the sensitivity of the modelled NO_2 and O_3 concentrations to changes in the assumed future background ozone concentrations.

3.1. Modified background ozone

In the base model the assumption of conservation of oxidant for future projections of rural background O_3 results in an increase in background of O_3 for any decrease in NO_2. Where O_3 is below typical remote background levels such an assumption is reasonable since O_3 reductions are likely to be due to the presence of NO causing titration of O_3, however in typical high O_3 conditions photochemical reactions are dominant. For these high O_3 conditions ($O_3 > 40$ppb), the background O_3 concentration is therefore unchanged for future years in a modified algorithm which is as follows:

For 2001: $\quad OX_{2001} = O_3 + NO_2 - (0.1 \times NO_x)$

For future years: $\quad O_{3L} = OX_{2001} - NO_2 + (0.1 \times NO_x)$

$\qquad\qquad\qquad O_{3H} = O_{3(2001)}$

$\qquad\qquad\qquad O_{3int} = O_{3L} + ((OX_{2001} - 30)/10) \times (O_{3H} - O_{3L})$

If the 2001 OX is less than 30ppb, future ozone is set to O_{3L} if it is greater than 40ppb then the future ozone is set to O_{3H}, otherwise it is set to O_{3int}.

Table 3.1 gives a summary of the base and modified sets of future background ozone concentrations used in the modelling. Compared to the standard case annual average O_3 shows some increase and the peaks some decrease.

Table 3.1: Future NO_x, NO_2 and ozone concentrations

		2001	2010		2020	
		O_3	O_3	Modified O_3	O_3	Modified O_3
NO_x ($\mu g/m^3$)	Annual Average	18.0	12.3	12.3	9.6	9.6
	Maximum hourly average	302.9	206.9	206.9	160.9	160.9
	99.8[th] percentile of hourly averages	185.7	126.8	126.0	98.6	97.9
NO_2 ($\mu g/m^3$)	Annual Average	12.3	9.5	9.5	7.7	7.7
	Maximum hourly average	78.5	51.3	51.3	51.3	51.3
	99.8[th] percentile of hourly averages	74.7	50.6	50.5	48.4	48.3
O_3 ($\mu g/m^3$)	Annual Average	53.4	55.1	57.1	56.1	58.7
	Maximum 8-hour average	153.8	163.7	153.8	167.0	153.8
	Mean daily max 8-hour average	76.9	71.2	81.8	71.7	83.5
	No. days 8-hr ave exceeds 100$\mu g/m^3$	25	30	29	31	32
	No. days 8-hr ave exceeds 120$\mu g/m^3$	7	9	10	9	11

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Table 3.2 gives the population weighted annual average NO_2 concentration and the percentage area, population and road length in London predicted to exceed 40µg/m³ for each case considered. Table 3.3 gives the population weighted annual average O_3 concentration and the area and population in London with more than 10 exceedences of 100µg/m³ by the daily maximum 8-hour average concentration. Note that there are predicted to be less than 20 exceedences of 120µg/m³ for all of the AURN sites for both the base and modified ozone data.

Table 3.2: NO_2 statistics

	2010		2020	
	O_3	Modified O_3	O_3	Modified O_3
Population weighted mean (µg/m³)	35.0	34.6	31.2	30.9
% area exceeding 40µg/m³	13	12	6	6
% pop exceeding 40µg/m³	20	18	11	10
% road length exceeding 40µg/m³	37	36	23	22

Table 3.3: O_3 statistics

	2010		2020	
	O_3	Modified O_3	O_3	Modified O_3
Population weighted mean (µg/m³)	37.3	35.9	40.0	38.9
% area with more than 10 exceedences of 100µg/m³	81	79	90	87
% population with more than 10 exceedences of 100µg/m³	72	69	85	80

Tables 3.4 and 3.5 show the modelled concentrations of NO_2 at the AURN sites for 2010 and 2020 respectively. Tables 3.6 and 3.7 show the modelled concentrations of O_3 at the AURN sites for 2010 and 2020 respectively. Although the annual average background O_3 concentration has increased in the modified background O_3 projection the reduction in peak levels more than offsets this effect for the air quality metrics considered in London. The annual average NO_2 and O_3, and peak levels of NO_2 and O_3 all show some reduction over the base case projections.

Table 3.4: NO$_2$ concentrations for 2010 (µg/m³)

	Annual average NO$_2$			99.79th percentile of hourly average NO$_2$ concentrations		
	O$_3$	Modified O$_3$	% decrease	O$_3$	Modified O$_3$	% decrease
A3	**42**	**41**	1	132	128	4
Bromley	**40**	**40**	1	126	125	1
Camden	**54**	**54**	1	141	138	2
Cromwell Road	**62**	**61**	1	139	136	2
Haringey	**45**	**44**	1	139	136	2
Marylebone Road	**75**	**74**	1	157	154	2
Southwark Roadside	**55**	**55**	1	136	133	2
Tower Hamlets	**49**	**49**	1	138	133	3
Roadside average	*53*	*52*	*1*	*139*	*135*	*2*
Bexley	32	31	1	131	130	1
Bloomsbury	**50**	**50**	1	130	126	3
Brent	27	27	1	113	110	2
Eltham	31	31	1	126	126	1
Hackney	**42**	**41**	1	131	128	2
Hillingdon	**41**	**40**	1	125	121	4
Hounslow	38	38	1	109	106	3
North Kensington	**41**	**40**	1	117	112	5
Southwark Background	**43**	**43**	1	122	120	2
Sutton Suburban	28	28	1	116	112	4
Teddington	25	25	1	107	102	4
West London	39	39	1	112	110	2
Wandsworth	**44**	**43**	1	119	117	2
Background average	*37*	*37*	*1*	*120*	*117*	*3*
Average	*43*	*43*	*1*	*127*	*124*	*2*

Table 3.5: NO₂ concentrations for 2020 (µg/m³)

	Annual average NO₂			99.79th percentile of hourly average NO₂ concentrations		
	O₃	Modified O₃	% decrease	O₃	Modified O₃	% decrease
A3	37	36	1	123	118	5
Bromley	36	35	1	119	118	0
Camden	**50**	**49**	1	132	128	3
Cromwell Road	**57**	**56**	2	132	127	4
Haringey	**40**	39	1	131	129	1
Marylebone Road	**68**	**67**	2	146	141	3
Southwark Roadside	**50**	**49**	1	124	123	1
Tower Hamlets	**44**	**43**	1	130	126	3
Roadside average	*48*	*47*	*1*	*130*	*126*	*3*
Bexley	28	28	1	125	124	0
Bloomsbury	**47**	**46**	1	125	120	4
Brent	25	24	1	109	105	3
Eltham	28	27	1	121	119	2
Hackney	37	37	1	124	121	2
Hillingdon	36	35	1	118	114	4
Hounslow	34	34	1	104	101	4
North Kensington	38	38	1	113	107	6
Southwark Background	**40**	**40**	1	115	113	2
Sutton Suburban	25	25	1	108	106	3
Teddington	23	22	1	104	97	6
West London	37	36	1	108	106	2
Wandsworth	39	39	1	113	111	2
Background average	*33*	*33*	*1*	*114*	*111*	*3*
Average	*39*	*38*	*1*	*120*	*117*	*3*

Table 3.6: O₃ concentrations for 2010

	Annual average O₃ (µg/m³)			No. exceedences of 100µg/m³		No. exceedences of 120µg/m³	
	O₃	Modified O₃	% decrease	O₃	Modified O₃	O₃	Modified O₃
A3	32	31	3	4	3	1	1
Bromley	33	32	4	10	8	5	3
Camden	22	22	4	4	1	1	0
Cromwell Road	19	18	4	3	2	1	1
Haringey	29	28	4	6	4	1	1
Marylebone Road	12	12	4	0	0	0	0
Southwark Roadside	22	21	4	2	2	1	1
Tower Hamlets	26	25	4	6	3	1	1
Roadside average	*25*	*24*	*4*	*4*	*3*	*1*	*1*
Bexley	39	38	3	**13**	9	3	3
Bloomsbury	26	25	4	5	3	1	1
Brent	43	41	3	**16**	**13**	4	4
Eltham	40	39	3	**14**	**12**	4	3
Hackney	32	31	4	7	5	1	1
Hillingdon	32	31	3	4	2	1	0
Hounslow	35	34	3	**12**	9	3	3
North Kensington	32	31	4	7	5	2	1
Southwark Background	31	30	4	8	6	3	2
Sutton Suburban	43	41	3	**21**	**17**	4	4
Teddington	45	44	3	**24**	**24**	5	4
West London	33	32	4	8	5	3	1
Wandsworth	44	43	1	7	5	2	1
Background average	*37*	*37*	*1*	***11***	*9*	*3*	*2*
Average	*43*	*43*	*1*	*9*	*7*	*2*	*2*

Table 3.7: O₃ concentrations for 2020

	Annual average O$_3$ (µg/m³)			No. exceedences of 100µg/m³		No. exceedences of 120µg/m³	
	O$_3$	Modified O$_3$	% decrease	O$_3$	Modified O$_3$	O$_3$	Modified O$_3$
A3	36	35	4	7	4	2	1
Bromley	37	35	5	**11**	8	5	3
Camden	26	24	5	4	2	1	0
Cromwell Road	21	20	5	3	3	1	1
Haringey	33	31	5	7	5	2	1
Marylebone Road	15	15	5	1	0	0	0
Southwark Roadside	26	25	5	4	3	1	1
Tower Hamlets	30	29	5	7	4	3	1
Roadside average	*28*	*27*	*5*	*6*	*4*	*2*	*1*
Bexley	42	40	4	**15**	**11**	4	3
Bloomsbury	28	27	5	7	4	2	1
Brent	45	43	4	**20**	**15**	5	4
Eltham	43	41	4	**21**	**12**	6	3
Hackney	35	34	5	9	6	3	1
Hillingdon	36	35	4	8	4	1	1
Hounslow	38	36	4	**16**	9	5	3
North Kensington	34	33	5	8	5	3	1
Southwark Background	34	32	5	9	6	3	2
Sutton Suburban	45	43	4	**24**	**19**	6	4
Teddington	47	45	4	**26**	**24**	6	4
West London	36	34	5	**11**	5	3	1
Wandsworth	33	32	5	8	5	3	1
Background average	*38*	*37*	*4*	*14*	*10*	*4*	*2*
Average	*34*	*33*	*4*	*11*	*7*	*3*	*2*

3.2. Additional background ozone

The sensitivity of the modelled NO_2 and O_3 concentrations to increased levels of background ozone was also investigated. Modelling was carried out using the base background ozone with the addition of a constant 10µg/m³ and 20µg/m³ for each hour.

Table 3.8 gives the population weighted annual average NO_2 concentration and the percentage area, population and road length in London predicted to exceed 40µg/m³ for each case considered. Table 3.9 gives the population weighted annual average O_3 concentration and the area and population in London with more than 10 exceedences of 100µg/m³ by the daily maximum 8-hour average concentration. For the base case and with an additional 10µg/m³ of background ozone there are predicted to be less than 20 exceedences of 120µg/m³ by the daily maximum 8-hour average concentration. With an additional 20µg/m³, there are predicted to be more than 20 exceedences at two of the AURN sites. The area and population over which this occurs is not available.

Table 3.8: NO₂ statistics

	2010			2020		
	Base	**+ 10µg/m³**	**+ 20µg/m³**	**Base**	**+ 10µg/m³**	**+ 20µg/m³**
Population weighted mean (µg/m³)	35.0	36.4	37.7	31.2	32.3	33.5
% area exceeding 40µg/m³	13	16	21	6	8	10
% pop exceeding 40µg/m³	20	26	32	11	13	17
% road length exceeding 40µg/m³	37	43	48	23	27	31

Table 3.9: O₃ statistics

	2010			2020		
	Base	**+ 10µg/m³**	**+ 20µg/m³**	**Base**	**+ 10µg/m³**	**+ 20µg/m³**
Population weighted mean (µg/m³)	37.1	41.5	44.4	39.9	42.7	48.2
% area with more than 10 exceedences of 100µg/m³	81	90	93	89	92	96
% population with more than 10 exceedences of 100µg/m³	71	85	89	84	88	91

Tables 3.10 and 3.11 show the modelled concentrations of NO_2 at the AURN sites for 2010 and 2020 respectively. Tables 3.12 and 3.13 show the modelled concentrations of O_3 at the AURN sites for 2010 and 2020 respectively.

Table 3.10: NO$_2$ concentrations for 2010 (µg/m³)

	Annual average			99.79[th] percentile		
	Base	**+ 10µg/m³**	**+ 20µg/m³**	**Base**	**+ 10µg/m³**	**+ 20µg/m³**
A3	**42**	**44**	**46**	132	136	142
Bromley	**41**	**43**	**44**	127	132	139
Camden	**54**	**57**	**61**	142	150	157
Cromwell Road	**62**	**66**	**70**	139	147	153
Haringey	**45**	**47**	**49**	141	148	153
Marylebone Road	**75**	**80**	**86**	160	168	176
Southwark Roadside	**56**	**59**	**62**	138	144	150
Tower Hamlets	**50**	**53**	**55**	141	149	157
Roadside average	*53*	*56*	*59*	*140*	*147*	*154*
Bexley	33	34	36	139	145	152
Bloomsbury	**50**	**53**	**55**	132	139	148
Brent	27	28	29	116	121	127
Eltham	31	32	33	130	136	142
Hackney	**42**	**43**	**45**	132	139	146
Hillingdon	**41**	**43**	**45**	126	135	143
Hounslow	38	**40**	**41**	111	119	125
North Kensington	**41**	**42**	**44**	120	128	136
Southwark Background	**44**	**45**	**47**	123	129	136
Sutton Suburban	28	29	29	114	118	124
Teddington	25	26	26	106	111	117
West London	39	**41**	**42**	114	120	128
Wandsworth	**44**	**46**	**48**	120	128	136
Background average	*37*	*39*	*40*	*122*	*128*	*135*
Average	*43*	*45*	*47*	*129*	*135*	*142*

Table 3.11: NO$_2$ concentrations for 2020 (μg/m³)

	Annual average			99.79th percentile		
	Base	**+ 10μg/m³**	**+ 20μg/m³**	**Base**	**+ 10μg/m³**	**+ 20μg/m³**
A3	37	38	**40**	123	128	133
Bromley	36	38	39	121	125	133
Camden	**50**	**53**	**55**	133	142	149
Cromwell Road	**57**	**61**	**64**	132	140	149
Haringey	**40**	**42**	**43**	134	140	147
Marylebone Road	**69**	**73**	**78**	150	157	164
Southwark Roadside	**50**	**53**	**56**	127	135	142
Tower Hamlets	**45**	**47**	**49**	133	141	150
Roadside average	*48*	*51*	*53*	*132*	*138*	*146*
Bexley	30	31	32	135	143	149
Bloomsbury	**47**	**49**	**51**	128	135	142
Brent	25	25	26	111	117	124
Eltham	28	29	30	125	130	136
Hackney	37	39	**40**	126	133	142
Hillingdon	36	37	39	121	128	135
Hounslow	34	36	37	107	113	120
North Kensington	38	39	**41**	117	125	132
Southwark Background	**40**	**42**	**43**	116	123	131
Sutton Suburban	25	26	26	107	112	120
Teddington	22	23	24	102	106	112
West London	37	38	39	110	117	124
Wandsworth	39	**41**	**43**	115	121	129
Background average	*34*	*35*	*36*	*117*	*123*	*131*
Average	*39*	*41*	*43*	*122*	*129*	*136*

Table 3.12: O₃ concentrations for 2010

	Annual average ($\mu g/m^3$)			No. exceedences of $100\mu g/m^3$			No. exceedences of $120\mu g/m^3$		
	Base	**+ 10µg/m³**	**+ 20µg/m³**	**Base**	**+ 10µg/m³**	**+ 20µg/m³**	**Base**	**+ 10µg/m³**	**+ 20µg/m³**
A3	32	38	45	4	10	**19**	1	2	3
Bromley	33	39	46	10	**16**	**37**	4	6	9
Camden	22	27	33	4	4	9	1	1	4
Cromwell Road	19	22	27	3	3	6	1	1	2
Haringey	29	35	42	6	8	**15**	1	3	6
Marylebone Road	12	15	18	0	0	1	0	0	0
Southwark Roadside	22	27	32	2	5	7	1	2	2
Tower Hamlets	25	31	37	5	7	**11**	1	3	4
Roadside average	*24*	*29*	*35*	*4*	*7*	*13*	*1*	*2*	*4*
Bexley	37	44	51	10	**25**	46	3	4	10
Bloomsbury	26	31	38	5	7	14	1	3	5
Brent	43	50	58	**16**	30	**61**	4	8	16
Eltham	40	47	54	**14**	26	65	3	7	14
Hackney	32	38	45	7	**12**	**23**	1	3	6
Hillingdon	32	38	45	4	10	**26**	1	1	3
Hounslow	35	41	48	**12**	**22**	48	3	5	12
North Kensington	32	39	46	7	**12**	**25**	2	3	7
Southwark Background	31	37	44	8	**14**	**28**	3	4	8
Sutton Suburban	43	50	58	**21**	**34**	69	4	10	**21**
Teddington	45	52	60	**24**	**38**	80	5	10	**24**
West London	33	40	47	8	**15**	**29**	3	4	8
Wandsworth	30	36	43	7	**11**	**17**	1	3	7
Background average	*35*	*42*	*49*	*11*	*20*	*41*	*3*	*5*	*11*
Average	*31*	*37*	*44*	*8*	*15*	*30*	*2*	*4*	*8*

Table 3.13: O₃ concentrations for 2020

	Annual average (µg/m³)			No. exceedences of 100µg/m³			No. exceedences of 120µg/m³		
	Base	**+ 10µg/m³**	**+ 20µg/m³**	**Base**	**+ 10µg/m³**	**+ 20µg/m³**	**Base**	**+ 10µg/m³**	**+ 20µg/m³**
A3	36	42	49	7	**15**	**29**	2	3	7
Bromley	36	43	50	**11**	**25**	**42**	5	7	11
Camden	26	31	37	4	7	9	1	1	4
Cromwell Road	21	26	31	3	5	7	1	2	3
Haringey	33	39	46	7	**11**	**23**	2	5	7
Marylebone Road	15	18	22	1	1	1	0	0	0
Southwark Roadside	26	31	37	4	6	**11**	1	2	4
Tower Hamlets	29	35	42	7	**11**	**18**	2	3	6
Roadside average	*28*	*33*	*39.2*	*6*	*10*	*18*	*2*	*3*	*5*
Bexley	40	47	54	**11**	**26**	**60**	3	5	11
Bloomsbury	28	34	41	7	9	**17**	2	3	6
Brent	45	53	61	**19**	**36**	**74**	5	9	19
Eltham	43	50	57	**21**	**33**	**71**	6	10	21
Hackney	35	42	49	9	**15**	**33**	3	6	9
Hillingdon	36	43	50	8	**13**	**33**	1	3	7
Hounslow	38	45	52	**16**	**23**	**59**	5	8	16
North Kensington	35	41	49	8	**17**	**32**	3	6	7
Southwark Background	33	40	47	8	**15**	**30**	3	7	8
Sutton Suburban	45	53	61	**24**	**39**	**80**	6	11	**24**
Teddington	47	55	63	**26**	**46**	**89**	6	12	**26**
West London	36	43	50	**11**	**22**	**34**	3	7	10
Wandsworth	34	40	47	7	**13**	**32**	3	4	7
Background average	*38*	*45*	*52*	*13*	*24*	*50*	*4*	*7*	*13*
Average	*34*	*40*	*47*	*10*	*19*	*37*	*3*	*5*	*10*

4. Primary NO₂ emissions

Modelling has been carried out for 2010 and 2020 taking into account different primary NO_2 emission fractions. Three cases have been considered: 10%; 15%; and 20% primary NO_2. The AQEG report on trends in primary NO_2[2] includes a prediction of the total primary NO_2 percentage of 19.3% for London for 2010.

Table 4.1 gives the population weighted annual average NO_2 concentration and the percentage area, population and road length in London predicted to exceed 40µg/m³ for each case considered. Table 4.2 gives the population weighted annual average O_3 concentration and the area and population in London with more than 10 exceedences 100µg/m³ by the daily maximum 8-hour average concentration.

Table 4.1: NO₂ statistics

	2010			2020		
	10%	**15%**	**20%**	**10%**	**15%**	**20%**
Population weighted mean (µg/m³)	35.0	36.5	38.1	31.2	32.1	33.3
% area exceeding 40µg/m³	13	17	22	6	8	10
% population exceeding 40µg/m³	20	27	34	11	13	16
% road length exceeding 40µg/m³	37	43	51	23	26	30

Table 4.2: O₃ statistics

	2010			2020		
	10%	**15%**	**20%**	**10%**	**15%**	**20%**
Population weighted mean	36.9	38.0	39.0	39.9	40.5	41.0
% area with more than 10 exceedences	81	83	86	89	90	91
% population with more than 10 exceedences	71	75	79	84	85	86

Tables 4.3 and 4.4 show the modelled concentrations of NO_2 at the AURN sites for 2010 and 2020 respectively. Tables 4.5 and 4.6 show the modelled concentrations of O_3 at the AURN sites for 2010 and 2020 respectively.

Figures 4.1a and b show the annual average NO_2 concentrations for 2010 assuming 10% and 20% primary NO_2. Figures 4.2a and b show the 99.79[th] percentile of hourly average NO_2 concentrations for 2010 assuming 10% and 20% primary NO_2.

Figures 4.3a and b show the annual average O_3 concentrations for 2010 assuming 10% and 20% primary NO_2. Figures 3.4a and b and Figures 4.5a and b show the number of days during which the 8-hour average O_3 concentration exceeded 100µg/m³ and 120µg/m³ assuming 10% and 20% primary NO_2.

For the annual average, most of the increase in emitted NO_2 directly impacts on the annual average NO_2 concentrations, with a relatively small percentage of the increase in available oxidant being converted to ozone. For example, of the increase in emitted NO_2 in 2010 taking averages over all sites, 68% remains as NO_2, 28% is used to generate O_3 and the

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[2] *Trends in Primary Nitrogen Dioxide in the UK, Draft report for comment,* AQEG, August 2006

remainder is lost in other reactions. Small quantities of oxidant are also generated by photochemical reactions of VOCs. At roadside sites, for example Marylebone Road and Cromwell Road, the increases in NO_2 concentrations are large – the NO_2 concentration for the 2010 projection for 20% primary emissions of NO_2 being as large as the 2001 concentration for 10% primary emissions.

The increase in primary NO_2 emissions from 10% to 20% is predicted to increase the area of exceedence of 40µg/m³ and the population exposed to concentrations exceeding 40µg/m³ in 2010 by approximately 70%.

There are large changes in the 99.79[th] percentage of hourly averages with exceedences of 200µg/m^3 being predicted in Marylebone Road in 2010 for a primary NO_2 fraction of 20% and Figure 4.2b shows significant areas of exceedence of the standard across the eastern edge of London.

Table 4.1: NO$_2$ concentrations for 2010 (µg/m³)

	Annual average			99.79th percentile		
	10% NO$_2$	15% NO$_2$	20% NO$_2$	10% NO$_2$	15% NO$_2$	20% NO$_2$
A3	**42**	**44**	**46**	132	146	163
Bromley	**40**	**42**	**44**	127	146	167
Camden	**55**	**58**	**61**	143	159	180
Cromwell Road	**62**	**67**	**72**	139	158	179
Haringey	**46**	**48**	**50**	142	157	173
Marylebone Road	**76**	**85**	**94**	162	192	**226**
Southwark Roadside	**56**	**59**	**63**	139	152	172
Tower Hamlets	**50**	**53**	**55**	143	160	175
Roadside average	*53*	*57*	*61*	*141*	*159*	*179*
Bexley	31	32	34	137	152	172
Bloomsbury	**51**	**54**	**57**	137	157	177
Brent	28	28	28	117	124	134
Eltham	31	32	33	132	146	166
Hackney	**42**	**44**	**46**	134	145	157
Hillingdon	**42**	**44**	**46**	134	141	152
Hounslow	39	**40**	**42**	111	120	133
North Kensington	**41**	**43**	**44**	121	131	139
Southwark Background	**44**	**46**	**48**	126	137	151
Sutton Suburban	28	29	30	112	121	134
Teddington	26	26	26	105	112	125
West London	**40**	**41**	**43**	122	135	150
Wandsworth	**44**	**46**	**48**	115	126	139
Background average	*37*	*39*	*40*	*123*	*134*	*148*
Average	*44*	*46*	*48*	*130*	*144*	*160*

Table 4.2: NO$_2$ concentrations for 2020 (µg/m³)

	Annual average			99.79th percentile		
	10% NO$_2$	15% NO$_2$	20% NO$_2$	10% NO$_2$	15% NO$_2$	20% NO$_2$
A3	37	38	**40**	120	134	150
Bromley	36	37	39	120	135	153
Camden	**50**	**52**	**55**	133	149	165
Cromwell Road	**57**	**61**	**66**	133	149	165
Haringey	**41**	**43**	**44**	133	145	161
Marylebone Road	**69**	**76**	**84**	149	172	199
Southwark Roadside	**50**	**53**	**56**	127	139	155
Tower Hamlets	**45**	**46**	**49**	131	146	159
Roadside average	*48*	*51*	*54*	*131*	*146*	*163*
Bexley	28	29	30	126	142	157
Bloomsbury	**47**	**50**	**52**	131	147	164
Brent	24	25	25	110	114	125
Eltham	27	28	29	123	136	152
Hackney	38	39	**41**	126	135	147
Hillingdon	36	37	38	119	123	134
Hounslow	34	35	36	104	112	122
North Kensington	38	39	**40**	118	125	134
Southwark Background	**40**	**42**	**43**	117	126	138
Sutton Suburban	25	25	26	103	114	126
Teddington	22	22	23	100	106	115
West London	37	38	39	114	127	141
Wandsworth	39	**41**	**42**	110	118	131
Background average	*34*	*35*	*36*	*116*	*125*	*137*
Average	*39*	*41*	*43*	*121*	*133*	*147*

Table 4.3: O$_3$ concentrations for 2010

	Annual average (µg/m³)			No. exceedences of 100µg/m³			No. exceedences of 120µg/m³		
	10% NO$_2$	15% NO$_2$	20% NO$_2$	10% NO$_2$	15% NO$_2$	20 % NO$_2$	10% NO$_2$	15% NO$_2$	20% NO$_2$
A3	32	33	34	4	4	5	1	1	1
Bromley	33	34	35	10	10	10	5	5	5
Camden	22	23	25	4	4	4	1	1	1
Cromwell Road	18	19	21	3	3	3	1	1	1
Haringey	28	29	31	6	6	7	1	1	1
Marylebone Road	12	13	14	0	0	0	0	0	0
Southwark Roadside	22	23	25	2	3	3	1	1	1
Tower Hamlets	26	27	28	5	6	6	1	2	2
Roadside average	*24*	*25*	*27*	*4*	*5*	*5*	*1*	*2*	*2*
Bexley	39	40	41	**13**	**13**	**13**	3	3	3
Bloomsbury	26	27	28	5	6	7	1	1	1
Brent	43	43	44	**16**	**17**	**19**	4	4	5
Eltham	40	41	42	**14**	**16**	**19**	4	5	6
Hackney	31	32	33	7	7	8	1	2	2
Hillingdon	31	32	33	4	4	4	1	1	1
Hounslow	34	35	36	**12**	**12**	**13**	3	3	3
North Kensington	32	33	34	7	8	8	2	3	3
Southwark Background	31	32	33	8	8	8	3	3	3
Sutton Suburban	43	43	44	**21**	**22**	**24**	4	4	5
Teddington	45	45	46	**24**	**24**	**25**	5	5	6
West London	33	34	35	8	9	10	3	3	3
Wandsworth	30	31	32	7	7	7	2	3	3
Background average	*35*	*36*	*37*	***11***	***12***	***13***	*3*	*3*	*3*
Average	*31*	*32*	*33*	*9*	*9*	*10*	*2*	*2*	*3*

Table 4.4: O₃ concentrations for 2020

	Annual average (µg/m³)			No. exceedences of 100µg/m³			No. exceedences of 120µg/m³		
	10% NO₂	15% NO₂	20% NO₂	10% NO₂	15% NO₂	20% NO₂	10% NO₂	15% NO₂	20% NO₂
A3	36	37	38	7	8	9	2	2	2
Bromley	37	38	39	**11**	**11**	**11**	5	5	5
Camden	25	27	28	4	5	5	1	1	1
Cromwell Road	21	22	24	3	3	4	1	1	1
Haringey	32	33	34	7	7	7	2	3	3
Marylebone Road	15	16	17	1	1	1	0	0	0
Southwark Roadside	26	27	28	4	4	5	1	1	2
Tower Hamlets	30	31	32	7	7	7	3	3	3
Roadside average	*28*	*29*	*30*	*6*	*6*	*6*	*2*	*2*	*2*
Bexley	42	43	43	**15**	**17**	**19**	4	4	5
Bloomsbury	28	29	31	7	7	7	2	3	3
Brent	45	46	47	**19**	**21**	**21**	5	5	5
Eltham	43	44	44	**21**	**21**	**22**	6	6	6
Hackney	35	36	37	9	10	10	3	3	3
Hillingdon	36	37	38	8	9	10	1	1	1
Hounslow	38	39	40	**16**	**17**	**19**	5	5	5
North Kensington	34	35	36	8	9	10	3	3	3
Southwark Background	33	34	35	9	10	**11**	3	3	3
Sutton Suburban	45	46	47	**24**	**24**	**26**	6	6	7
Teddington	47	48	48	**26**	**27**	**27**	6	6	7
West London	36	37	38	**11**	**11**	**11**	3	3	3
Wandsworth	34	35	36	7	7	9	3	3	3
Background average	*38*	*39*	*40*	*14*	*15*	*16*	*4*	*4*	*4*
Average	*34*	*35*	*36*	*11*	*11*	*12*	*3*	*3*	*3*

CERC

NO2 (µg/m³)
- \> 56
- 52 - 56
- 48 - 52
- 44 - 48
- 40 - 44
- 36 - 40
- 32 - 36
- 28 - 32
- 24 - 28
- 20 - 24
- < 20

0   5   10   Kilometers
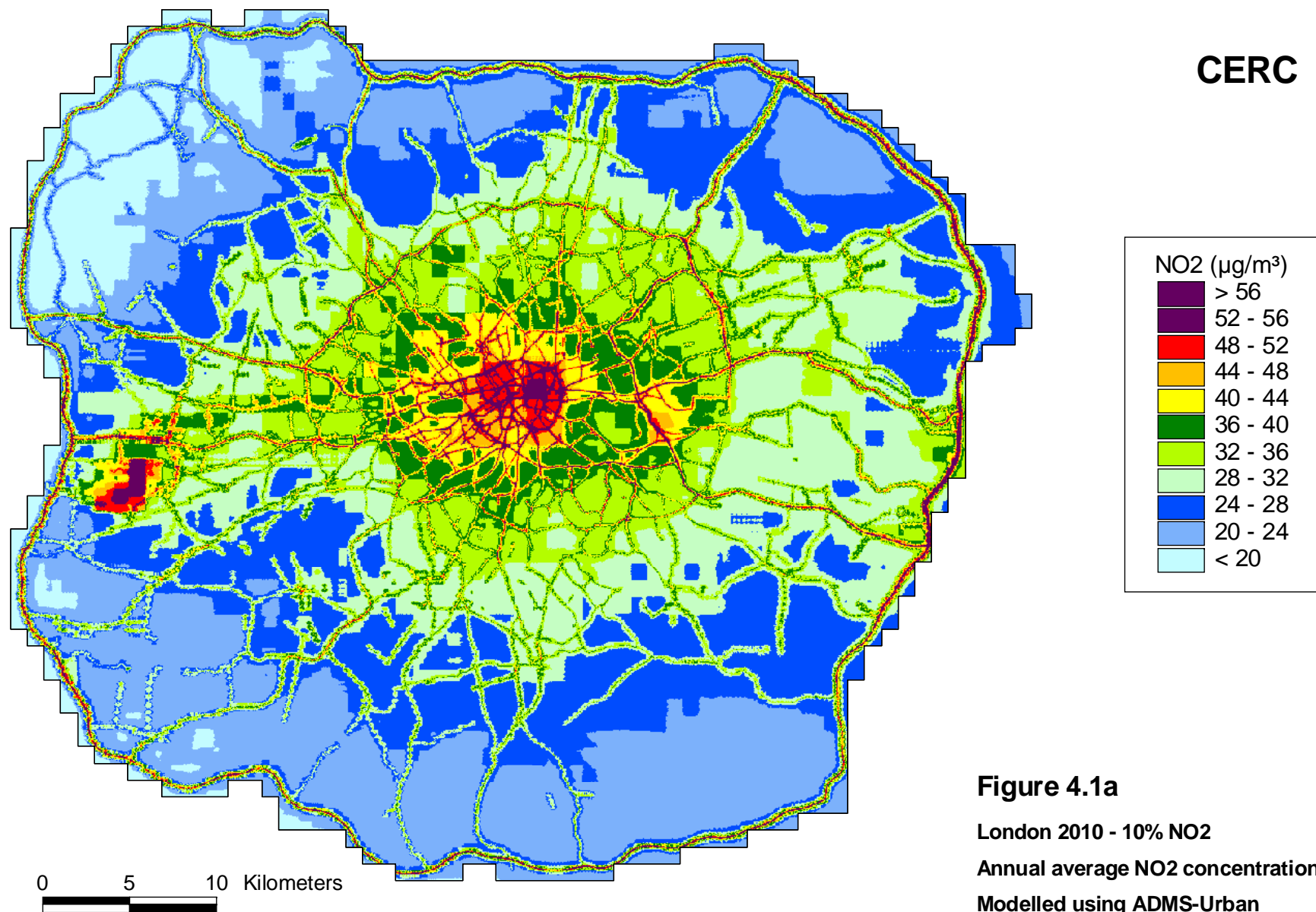
Figure 4.1a

London 2010 - 10% NO2

Annual average NO2 concentration

Modelled using ADMS-Urban

NO2 (µg/m³)

- > 56
- 52 - 56
- 48 - 52
- 44 - 48
- 40 - 44
- 36 - 40
- 32 - 36
- 28 - 32
- 24 - 28
- 20 - 24
- < 20

0   5   10   Kilometers
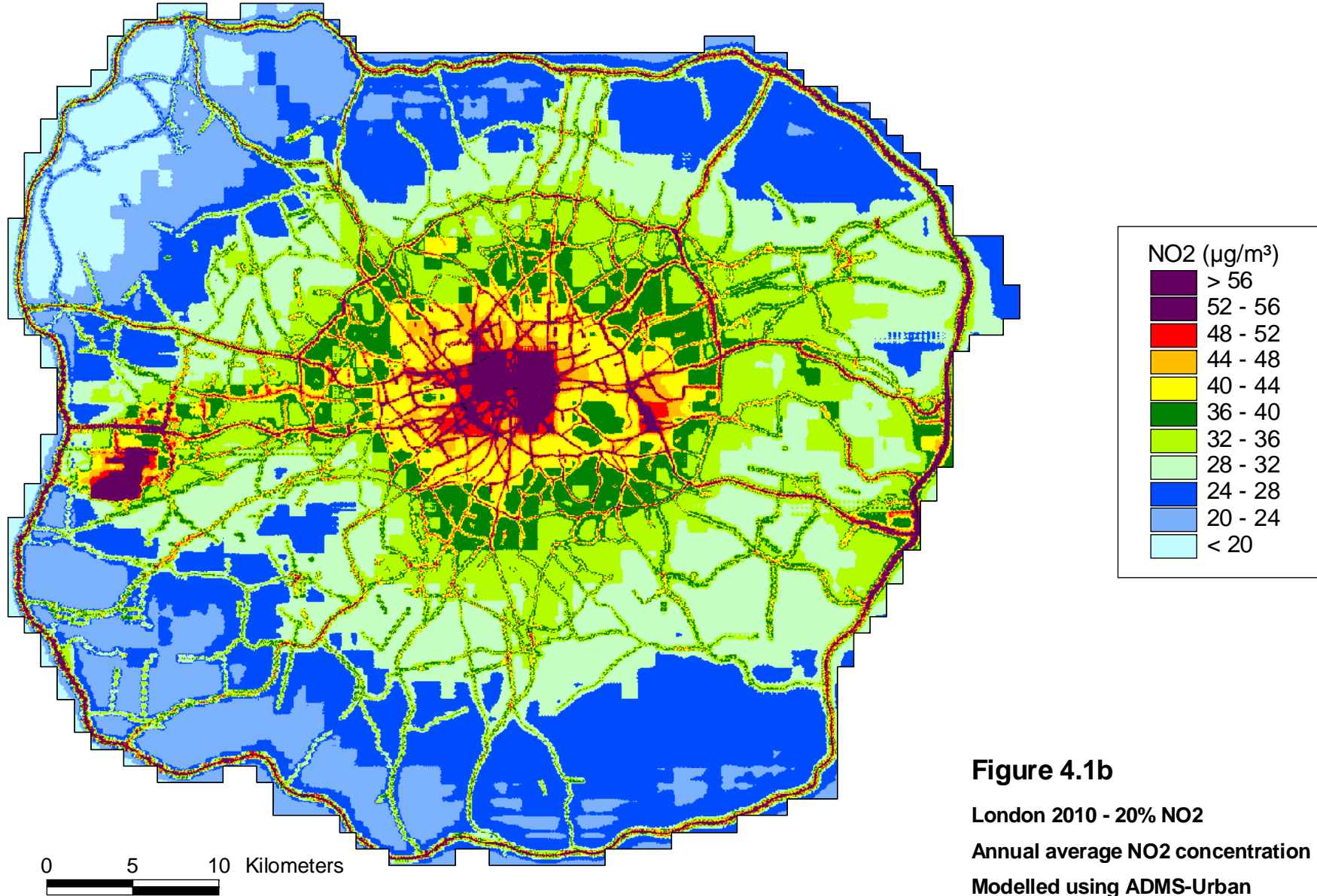
Figure 4.1b

London 2010 - 20% NO2

Annual average NO2 concentration

Modelled using ADMS-Urban

CERC

NO2 (µg/m³)
- < 125
- 125 - 150
- 150 - 175
- 175 - 200
- 200 - 225
- 225 - 250
- 250 - 275
- 275 - 300
- > 300
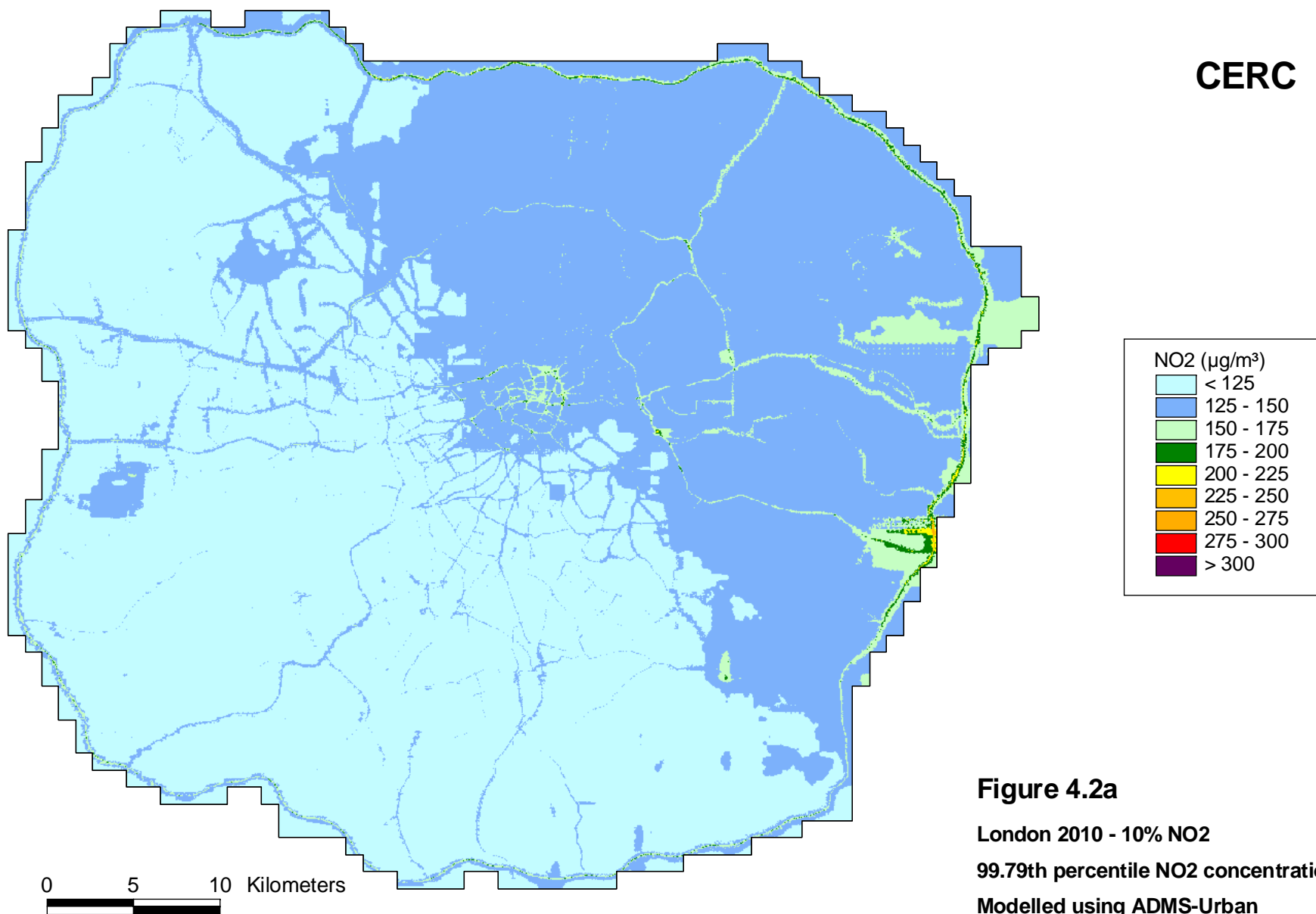
Figure 4.2a

London 2010 - 10% NO2

99.79th percentile NO2 concentration

Modelled using ADMS-Urban

0   5   10   Kilometers

CERC

NO2 (µg/m³)
- < 125
- 125 - 150
- 150 - 175
- 175 - 200
- 200 - 225
- 225 - 250
- 250 - 275
- 275 - 300
- > 300

0   5   10   Kilometers
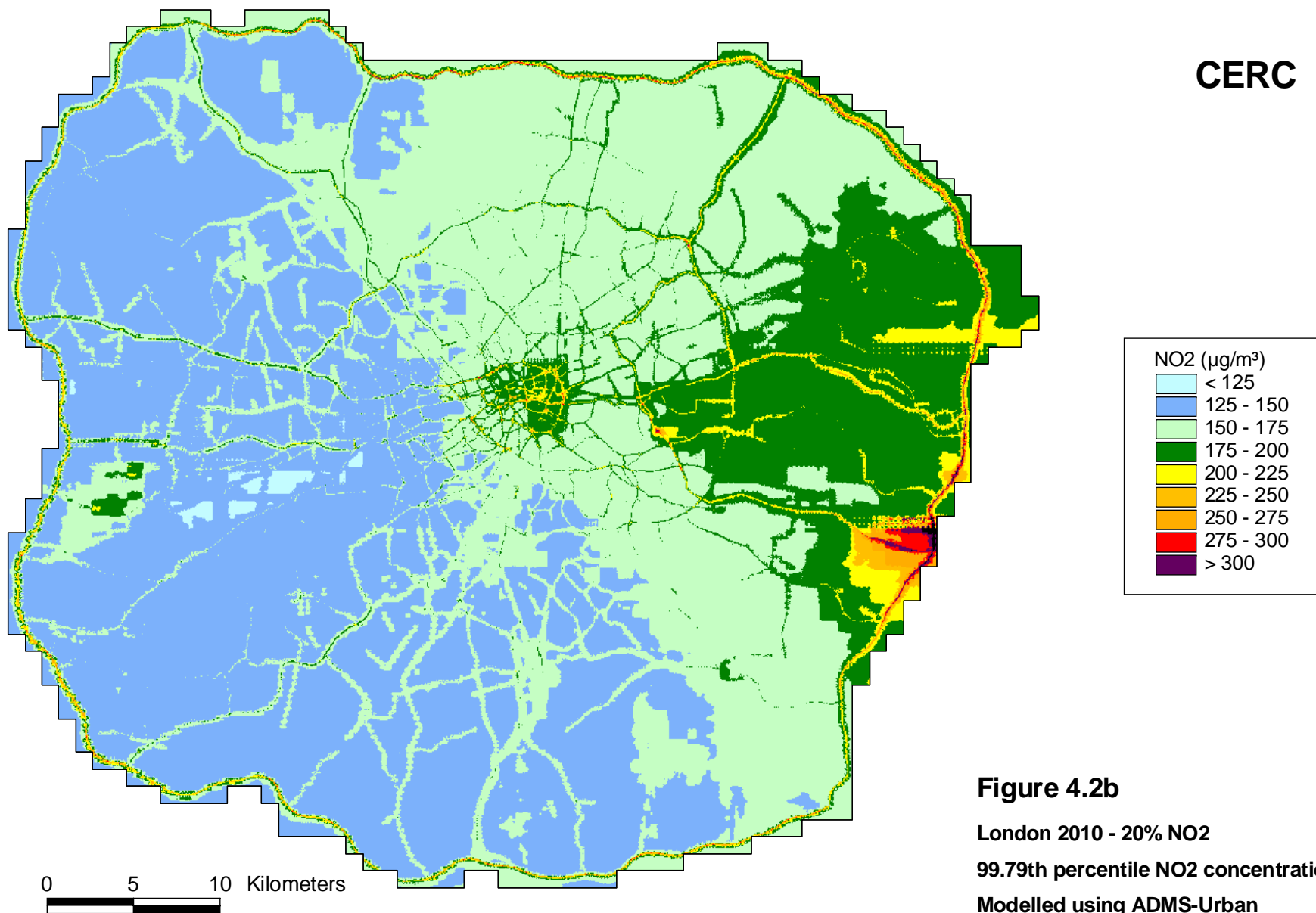
Figure 4.2b

London 2010 - 20% NO2

99.79th percentile NO2 concentration

Modelled using ADMS-Urban

O3 (µg/m³)

	> 52
	48 - 52
	44 - 48
	40 - 44
	36 - 40
	32 - 36
	28 - 32
	24 - 28
	20 - 24
	< 20

0   5   10   Kilometers
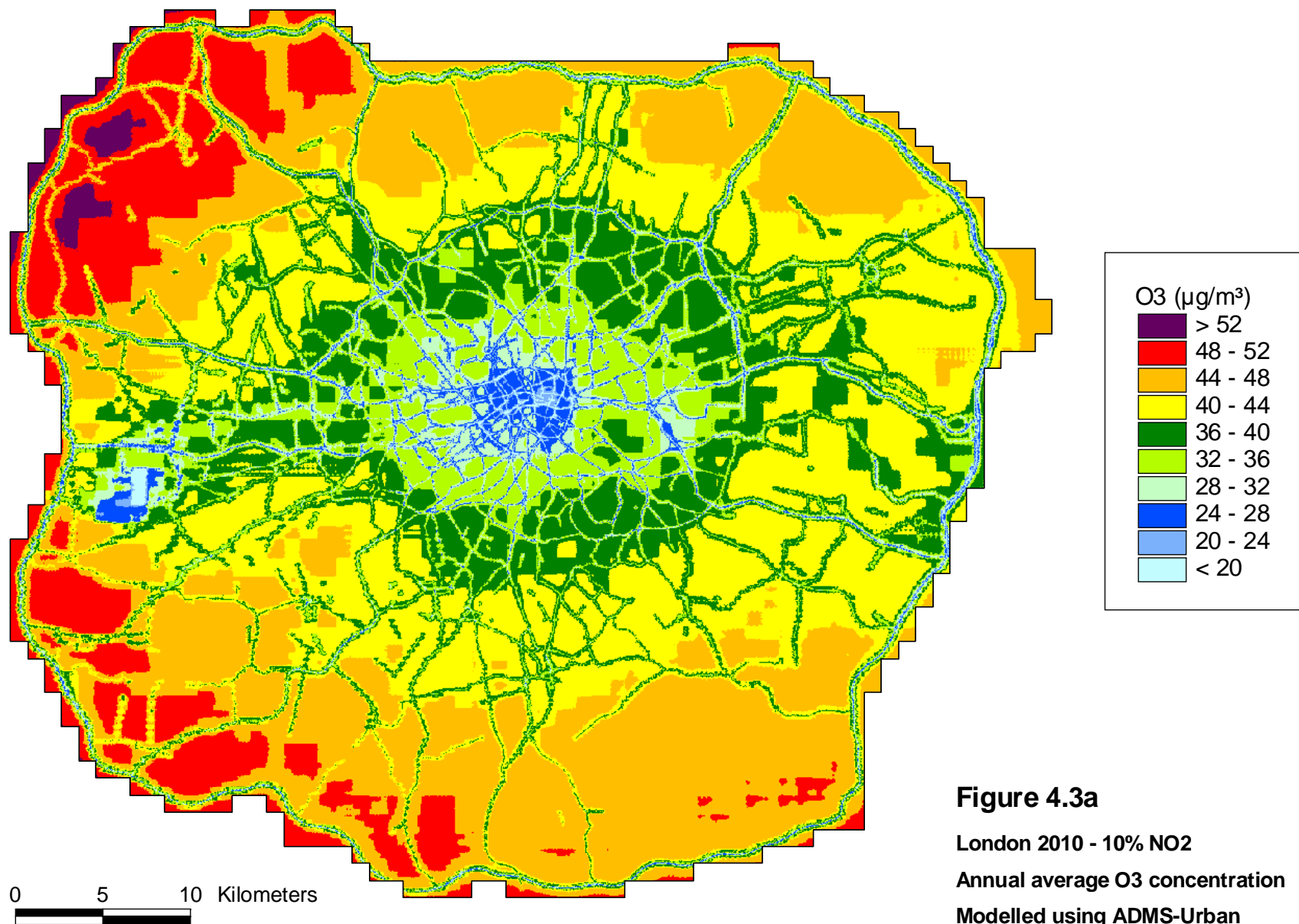
Figure 4.3a

London 2010 - 10% NO2

Annual average O3 concentration

Modelled using ADMS-Urban

O3 (µg/m³)

- > 52
- 48 - 52
- 44 - 48
- 40 - 44
- 36 - 40
- 32 - 36
- 28 - 32
- 24 - 28
- 20 - 24
- < 20
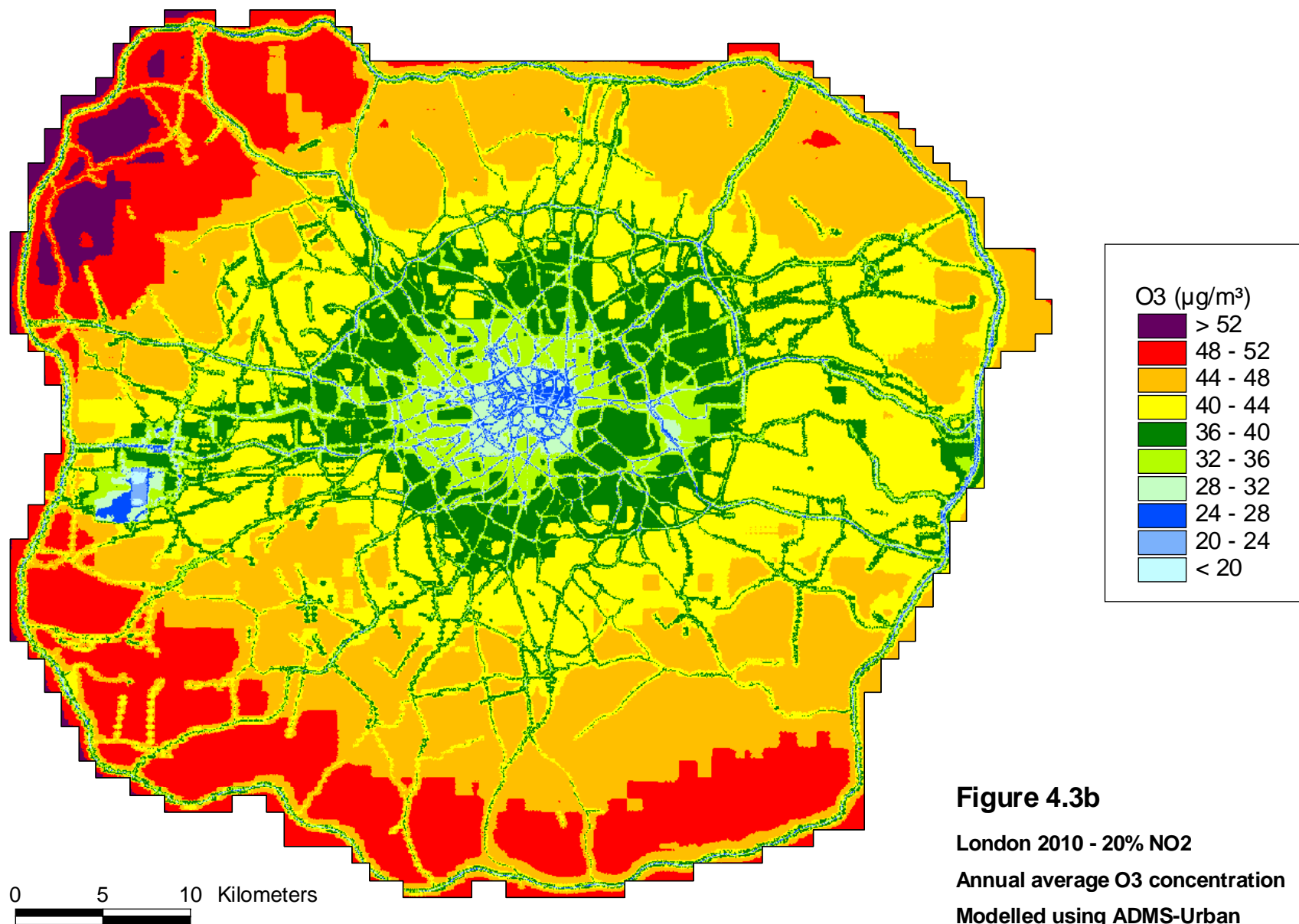
Figure 4.3b

London 2010 - 20% NO2

Annual average O3 concentration

Modelled using ADMS-Urban

0   5   10   Kilometers

No days
- >20 (orange)
- 10 - 20 (yellow)
- 5 - 10 (green)
- 0 - 5 (purple)

0   5   10 Kilometers

Figure 4.4a

London 2010 - 10% NO2

Number of days during which the maximum O3 concentration >100µg/m³

Modelled using ADMS-Urban

No days

- >20
- 10 - 20
- 5 - 10
- 0 - 5

Figure 4.4b

London 2010 - 20% NO2

Number of days during which the maximum O3 concentration >100µg/m³

Modelled using ADMS-Urban

0   5   10 Kilometers

No days

▯ (yellow)	>20
▯ (dark green)	10 - 20
▯ (green)	8 - 10
▯ (light green)	6 - 8
▯ (blue)	4 - 6
▯ (light purple)	2 - 4
▯ (light cyan)	0 - 2

0   5   10 Kilometers

Figure 4.5a

London 2010 - 10% NO2

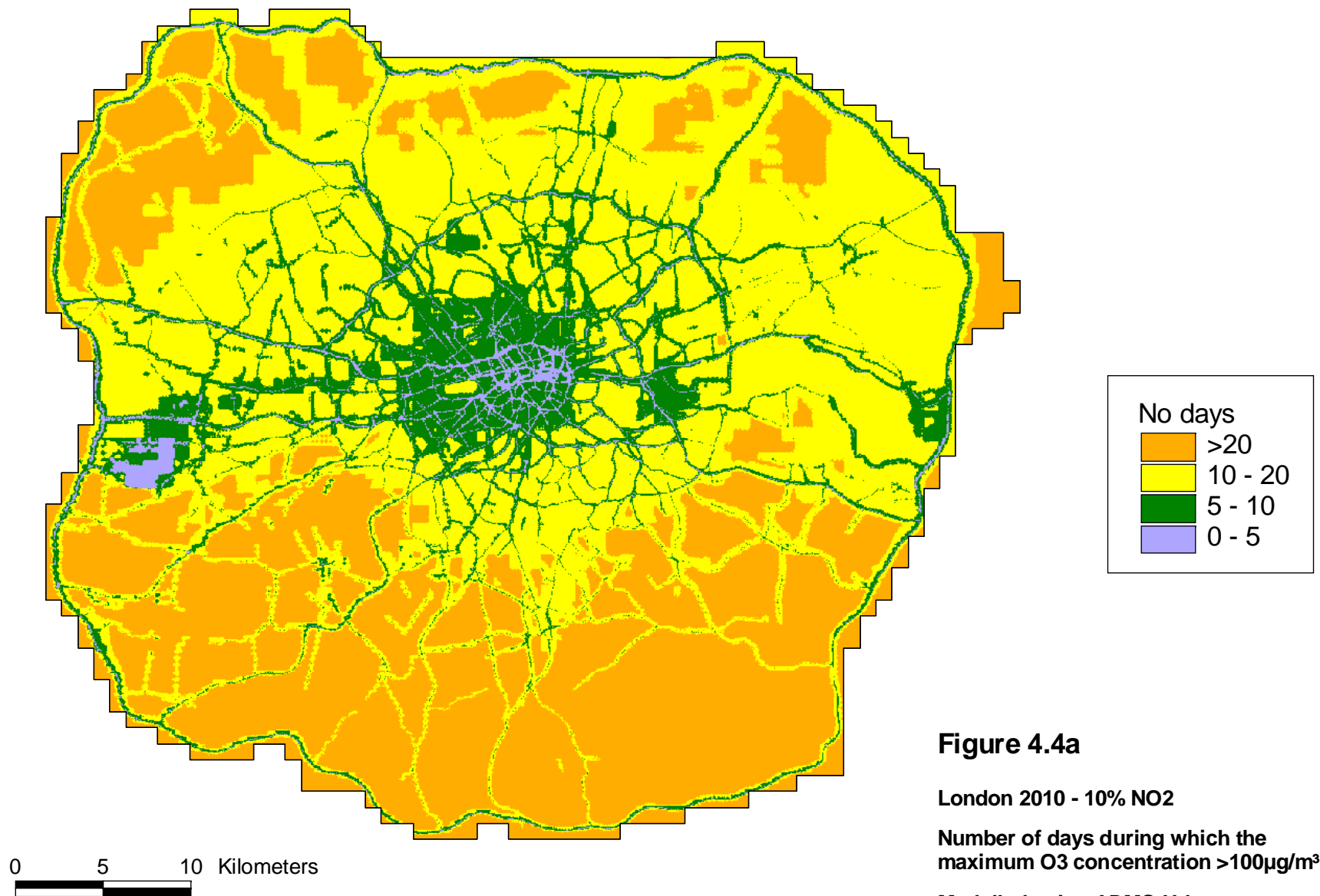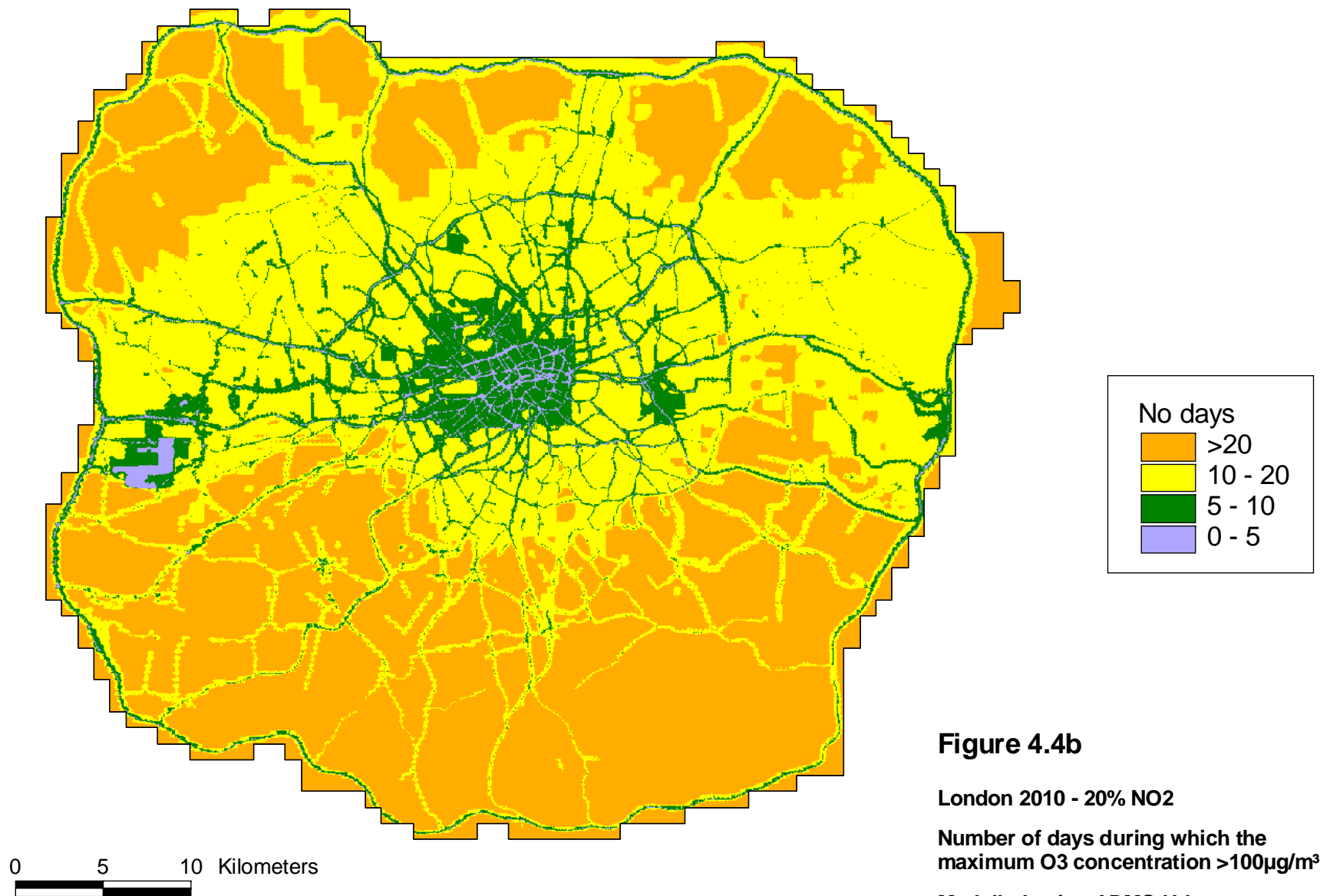**Number of days during which the maximum O3 concentration >120µg/m³**

Modelled using ADMS-Urban

Figure 4.5b

London 2010 - 20% NO2

Number of days during which the maximum O3 concentration >120µg/m³
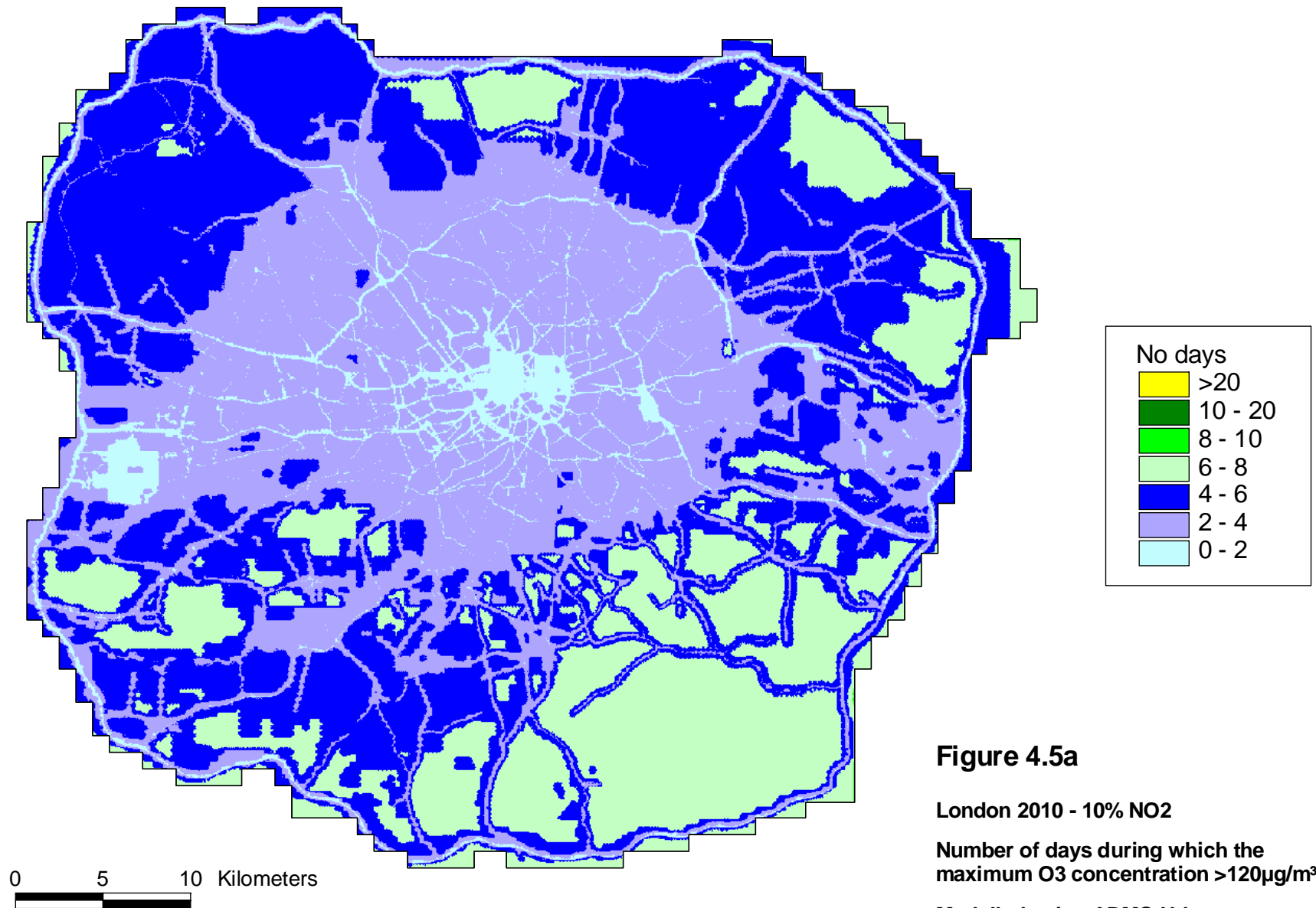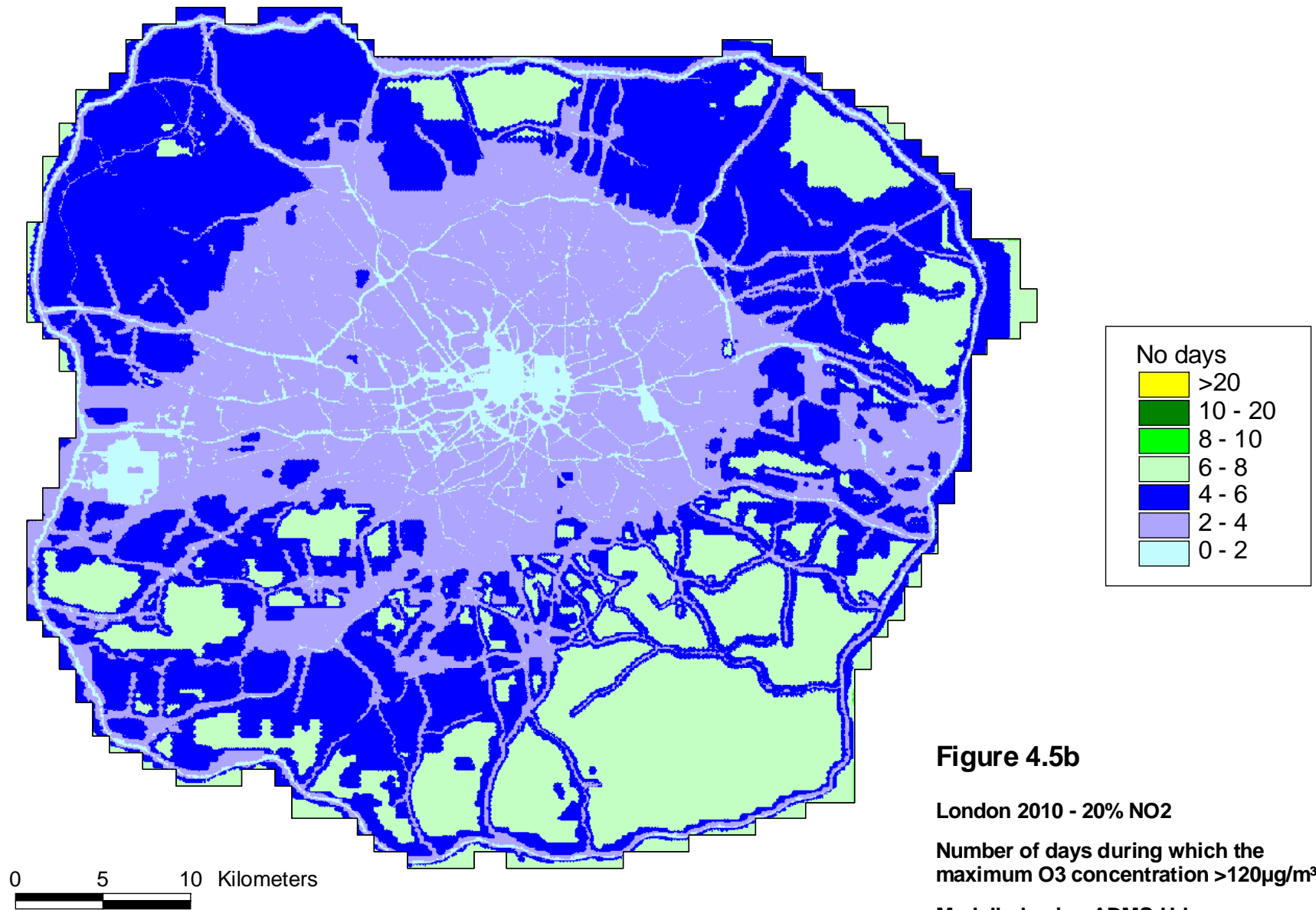
Modelled using ADMS-Urban

Legend — No days:
- >20
- 10 - 20
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 0 - 2

0   5   10 Kilometers

5. Base year 2003

Modelling for 2010 and 2020 was initially carried out using emissions, meteorological and background data for 2001. Further work has been carried out using data from 2003 with primary NO_2 emissions of 15% and 20% of NO_x.

Table 5.1 gives the population weighted annual average NO_2 concentration and the percentage area, population and road length in London predicted to exceed 40µg/m³ for each case considered. Table 5.2 gives the population weighted annual average O_3 concentration and the area and population in London with more than 10 exceedences 100µg/m³ by the daily maximum 8-hour average concentration.

Table 5.1: NO$_2$ statistics

Year	2010					2020				
Base Year	2001			2003		2001			2003	
Primary NO$_2$	10%	15%	20%	15%	20%	10%	15%	20%	15%	20%
Population weighted mean (µg/m³)	35.0	36.5	38.1	37.2	38.8	31.2	32.1	33.3	34.0	35.1
% area exceeding 40µg/m³	13	17	22	19	24	6	8	10	11	14
% population exceeding 40µg/m³	20	27	34	30	37	11	13	16	19	22
% road length exceeding 40µg/m³	37	43	51	46	53	23	26	30	33	37

Table 5.2 O$_3$ statistics

Year	2010					2020				
Base Year	2001			2003		2001			2003	
Primary NO$_2$	10%	15%	20%	15%	20%	10%	15%	20%	15%	20%
Population weighted mean (µg/m³)	36.9	38.0	39.0	41.7	42.1	39.9	40.5	41.0	42.8	43.3
% area with more than 10 exceedences	81	83	86	93	93	89	90	91	95	95
% population with more than 10 exceedences	71	75	79	88	89	84	85	86	90	91

Tables 5.3 and 5.4 show the modelled concentrations of NO_2 at the AURN sites for 2010 and 2020 respectively. Tables 5.5 and 5.6 show the modelled concentrations of O_3 at the AURN sites for 2010 and 2020 respectively. As compared with 2001, the 2003 results show a significant worsening of both NO_2 and O_3 for long-term and short-term average statistics. For 2010 with 20% of NO_x as primary NO_2, there is a n increase in exceedences of the annual average limit value for NO_2, and exceedences of the hourly limit value for NO_2 and eight-hour maximum objective for O_3 (both the Air Quality Strategy objective, 100µg/m³ not to be exceeded more than 10 times per year, and the EU target value, 120µg/m³ not to be exceeded more than 20 times per year).

Table 5.3: NO$_2$ concentrations for 2010 (µg/m³)

	Annual average					99.79th percentile				
	2001			2003		2001			2003	
	10% NO$_2$	15% NO$_2$	20 % NO$_2$	15% NO$_2$	20 % NO$_2$	10% NO$_2$	15% NO$_2$	20 % NO$_2$	15% NO$_2$	20 % NO$_2$
A3	**42**	**44**	**46**	**44**	**46**	120	146	163	147	167
Bromley	**40**	**42**	**44**	36	37	120	146	167	150	174
Camden	**55**	**58**	**61**	**58**	**61**	133	159	180	180	**204**
Cromwell Road	**62**	**67**	**72**	**63**	**66**	133	158	179	170	196
Haringey	**46**	**48**	**50**	**43**	**44**	133	157	173	161	179
Marylebone Road	**76**	**85**	**94**	**82**	**89**	149	192	**226**	**206**	**244**
Southwark Roadside	**56**	**59**	**63**	**49**	**51**	127	152	172	162	188
Tower Hamlets	**50**	**53**	**55**	**51**	**53**	131	160	175	168	192
Roadside average	*53*	*57*	*61*	*53*	*56*	*131*	*159*	*179*	*168*	*193*
Bexley	31	32	34	29	29	126	152	172	162	181
Bloomsbury	**51**	**54**	**57**	**62**	**66**	131	157	177	177	**201**
Brent	28	28	28	31	31	110	124	134	150	166
Eltham	31	32	33	30	30	123	146	166	154	171
Hackney	**42**	**44**	**46**	**42**	**43**	126	145	157	153	172
Hillingdon	**42**	**44**	**46**	**48**	**50**	119	141	152	169	194
Hounslow	39	**40**	**42**	**43**	**45**	104	120	133	147	167
North Kensington	**41**	**43**	**44**	**51**	**53**	118	131	139	159	187
Southwark Background	**44**	**46**	**48**	**44**	**45**	117	137	151	150	169
Sutton Suburban	28	29	30	28	29	103	121	134	131	148
Teddington	26	26	26	25	26	100	112	125	122	141
West London	**40**	**41**	**43**	**45**	**46**	114	135	150	140	158
Wandsworth	**44**	**46**	**48**	38	39	110	126	139	137	150
Background average	*37*	*39*	*40*	*40*	*41*	*116*	*134*	*148*	*150*	*170*
Average	*44*	*46*	*48*	*45*	*47*	*121*	*144*	*160*	*157*	*179*

Table 5.4: NO$_2$ concentrations for 2020 (µg/m³)

	Annual average					99.79th percentile				
	2001			2003		2001			2003	
	10% NO$_2$	15% NO$_2$	20 % NO$_2$	15% NO$_2$	20 % NO$_2$	10% NO$_2$	15% NO$_2$	20 % NO$_2$	15% NO$_2$	20 % NO$_2$
A3	37	38	**40**	39	**40**	120	134	150	139	155
Bromley	36	37	39	32	33	120	135	153	141	163
Camden	**50**	**52**	**55**	**54**	**56**	133	149	165	170	192
Cromwell Road	**57**	**61**	**66**	**58**	**61**	133	149	165	159	183
Haringey	**41**	**43**	**44**	39	**40**	133	145	161	154	168
Marylebone Road	**69**	**76**	**84**	**68**	**73**	149	172	199	182	**210**
Southwark Roadside	**50**	**53**	**56**	45	47	127	139	155	152	176
Tower Hamlets	**45**	**46**	**49**	46	48	131	146	159	158	182
Roadside average	*48*	*51*	*54*	*48*	*50*	*131*	*146*	*163*	*157*	*178*
Bexley	28	29	30	26	26	126	142	157	153	171
Bloomsbury	**47**	**50**	**52**	**60**	**63**	131	147	164	170	192
Brent	24	25	25	28	29	110	114	125	142	158
Eltham	27	28	29	27	27	123	136	152	147	162
Hackney	38	39	**41**	38	39	126	135	147	146	163
Hillingdon	36	37	38	**43**	**45**	119	123	134	159	179
Hounslow	34	35	36	39	**40**	104	112	122	139	155
North Kensington	38	39	**40**	**49**	**50**	118	125	134	154	177
Southwark Background	**40**	**42**	**43**	**41**	**42**	117	126	138	144	162
Sutton Suburban	25	25	26	26	26	103	114	126	124	142
Teddington	22	22	23	23	23	100	106	115	116	135
West London	37	38	39	**41**	**42**	114	127	141	133	150
Wandsworth	39	**41**	**42**	35	36	110	118	131	133	144
Background average	*34*	*35*	*36*	*37*	*38*	*116*	*125*	*137*	*143*	*161*
Average	*39*	*41*	*43*	*41*	*42*	*121*	*133*	*147*	*148*	*167*

Table 5.5: O₃ concentrations for 2010

	Annual average (µg/m³)					Exceedences of 100µg/m³					Exceedences of 120µg/m³				
	2001			2003		2001			2003		2001			2003	
	10% NO₂	15% NO₂	20 % NO₂	15% NO₂	20% NO₂	10% NO₂	15% NO₂	20 % NO₂	15% NO₂	20% NO₂	10% NO₂	15% NO₂	20 % NO₂	15% NO₂	20% NO₂
A3	32	33	34	38	39	4	4	5	**15**	**17**	1	1	1	8	9
Bromley	33	34	35	43	44	10	10	10	**29**	**33**	5	5	5	11	11
Camden	22	23	25	27	29	4	4	4	4	8	1	1	1	2	2
Cromwell Road	18	19	21	25	26	3	3	3	6	6	1	1	1	2	3
Haringey	28	29	31	37	38	6	6	7	**18**	**19**	1	1	1	8	9
Marylebone Road	12	13	14	16	18	0	0	0	0	0	0	0	0	0	0
Southwark Roadside	22	23	25	33	34	2	3	3	**11**	**12**	1	1	1	6	7
Tower Hamlets	26	27	28	32	33	5	6	6	**13**	**15**	1	2	2	4	5
Roadside average	*24*	*25*	*27*	*31*	*33*	*4*	*5*	*5*	*12*	*14*	*1*	*2*	*2*	*5*	*6*
Bexley	39	40	41	48	49	**13**	**13**	**13**	**41**	**41**	3	3	3	15	17
Bloomsbury	26	27	28	25	26	5	6	7	6	7	1	1	1	2	2
Brent	43	43	44	46	47	**16**	**17**	**19**	**35**	**35**	4	4	5	16	16
Eltham	40	41	42	47	48	**14**	**16**	**19**	**41**	**41**	4	5	6	17	17
Hackney	31	32	33	38	39	7	7	8	**19**	**20**	1	2	2	10	12
Hillingdon	31	32	33	34	35	4	4	4	**14**	**16**	1	1	1	6	6
Hounslow	34	35	36	38	39	**12**	**12**	**13**	**22**	**24**	3	3	3	9	9
North Kensington	32	33	34	32	33	7	8	8	**19**	**20**	2	3	3	6	7
Southwark Background	31	32	33	37	38	8	8	8	**13**	**15**	3	3	3	8	8
Sutton Suburban	43	43	44	49	50	**21**	**22**	**24**	**21**	**22**	4	4	5	16	17
Teddington	45	45	46	51	52	**24**	**24**	**25**	**39**	**41**	5	5	6	**21**	**22**
West London	33	34	35	41	42	8	9	10	**50**	**51**	3	3	3	11	13
Wandsworth	30	31	32	36	38	7	7	7	**18**	**18**	2	3	3	9	10
Background average	*35*	*36*	*37*	*40*	*41*	*11*	*12*	*13*	*26*	*27*	*3*	*3*	*3*	*11*	*12*
Average	*31*	*32*	*33*	*37*	*38*	*9*	*9*	*10*	*21*	*22*	*2*	*2*	*3*	*9*	*10*

Table 5.6: O₃ concentrations for 2020

	Annual average (µg/m³)					Exceedences of 100µg/m³					Exceedences of 120µg/m³				
	2001			2003		2001			2003		2001			2003	
	10% NO₂	15% NO₂	20 % NO₂	15% NO₂	20% NO₂	10% NO₂	15% NO₂	20 % NO₂	15% NO₂	20% NO₂	10% NO₂	15% NO₂	20 % NO₂	15% NO₂	20% NO₂
A3	36	37	38	42	43	7	8	9	**22**	**22**	2	2	2	10	11
Bromley	37	38	39	46	47	**11**	**11**	**11**	**36**	**38**	5	5	5	12	12
Camden	25	27	28	30	31	4	5	5	**11**	**12**	1	1	1	3	3
Cromwell Road	21	22	24	28	29	3	3	4	7	8	1	1	1	3	3
Haringey	32	33	34	40	41	7	7	7	**21**	**23**	2	3	3	13	13
Marylebone Road	15	16	17	24	24	1	1	1	4	4	0	0	0	1	1
Southwark Roadside	26	27	28	36	37	4	4	5	**14**	**15**	1	1	2	7	8
Tower Hamlets	30	31	32	35	36	7	7	7	**17**	**19**	3	3	3	7	7
Roadside average	*28*	*29*	*30*	*35*	*36*	*6*	*6*	*6*	*17*	*18*	*2*	*2*	*2*	*7*	*7*
Bexley	42	43	43	51	51	**15**	**17**	**19**	**44**	**44**	4	4	5	19	19
Bloomsbury	28	29	31	26	28	7	7	7	7	9	2	3	3	3	3
Brent	45	46	47	48	49	**19**	**21**	**21**	**40**	**41**	5	5	5	17	17
Eltham	43	44	44	50	51	**21**	**21**	**22**	**42**	**43**	6	6	6	17	17
Hackney	35	36	37	41	42	9	10	10	**23**	**23**	3	3	3	14	15
Hillingdon	36	37	38	38	39	8	9	10	**17**	**17**	1	1	1	7	7
Hounslow	38	39	40	41	42	**16**	**17**	**19**	**28**	**30**	5	5	5	9	9
North Kensington	34	35	36	34	35	8	9	10	**17**	**17**	3	3	3	7	8
Southwark Background	33	34	35	39	40	9	10	**11**	**24**	**25**	3	3	3	8	10
Sutton Suburban	45	46	47	51	52	**24**	**24**	**26**	**42**	**45**	6	6	7	18	**20**
Teddington	47	48	48	53	54	**26**	**27**	**27**	**53**	**54**	6	6	7	**22**	**22**
West London	36	37	38	43	44	**11**	**11**	**11**	**33**	**33**	3	3	3	14	14
Wandsworth	34	35	36	39	40	7	7	9	**19**	**23**	3	3	3	10	10
Background average	*38*	*39*	*40*	*43*	*44*	*14*	*15*	*16*	*30*	*31*	*4*	*4*	*4*	*13*	*13*
Average	*34*	*35*	*36*	*40*	*41*	*11*	*11*	*12*	*25*	*26*	*3*	*3*	*3*	*11*	*11*

6.   Discussion

In this report we have described further modelling that has been carried out to investigate the sensitivity of the modelled concentrations to changes in background ozone concentrations, primary NO_2 emissions and the base year considered.   The following tests have been carried out:

- Modified background ozone;
- Additional ozone background;
- Changes in primary NO_2 emissions; and
- Change of base year from 2001 to 2003.

A modified algorithm for background O_3 projections results in only modest changes to the O_3 background.   In London both the NO_2 and O_3 climates showed marginal improvements. Increasing the background O_3 concentration results in significant worsening of both NO_2 and O_3 climates.   In 2020 with a $20\mu gm^{-3}$ increase in background O_3, over 95% of the London area is predicted to experience more than 10 exceedences of $100\mu gm^{-3}$ by the 8-hour daily maximum.

Primary NO_2 emissions were increased from the base case (10%) to 15%, typical of conditions in 2003, and to 20% typical of projections for 2010.   These changes significantly impact on NO_2 concentrations, both the annual mean and hourly mean.   In 2010 with 20% primary NO_2 emission exceedences of the hourly standard are likely of occur at the busiest roads.   Increased primary NO_2 emissions cause a relatively small increase in levels of O_3.

In 2003 high temperatures across Europe resulted in elevated background O_3 levels.   The impacts of these cause a significant worsening of both NO_2 and O_3 concentrations in London with widespread exceedence of the standards for annual average NO_2 and 8 hourly O_3 maxima; exceedences of the NO_2 hourly standard are also predicted at roadside both in 2010 and 2020.

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