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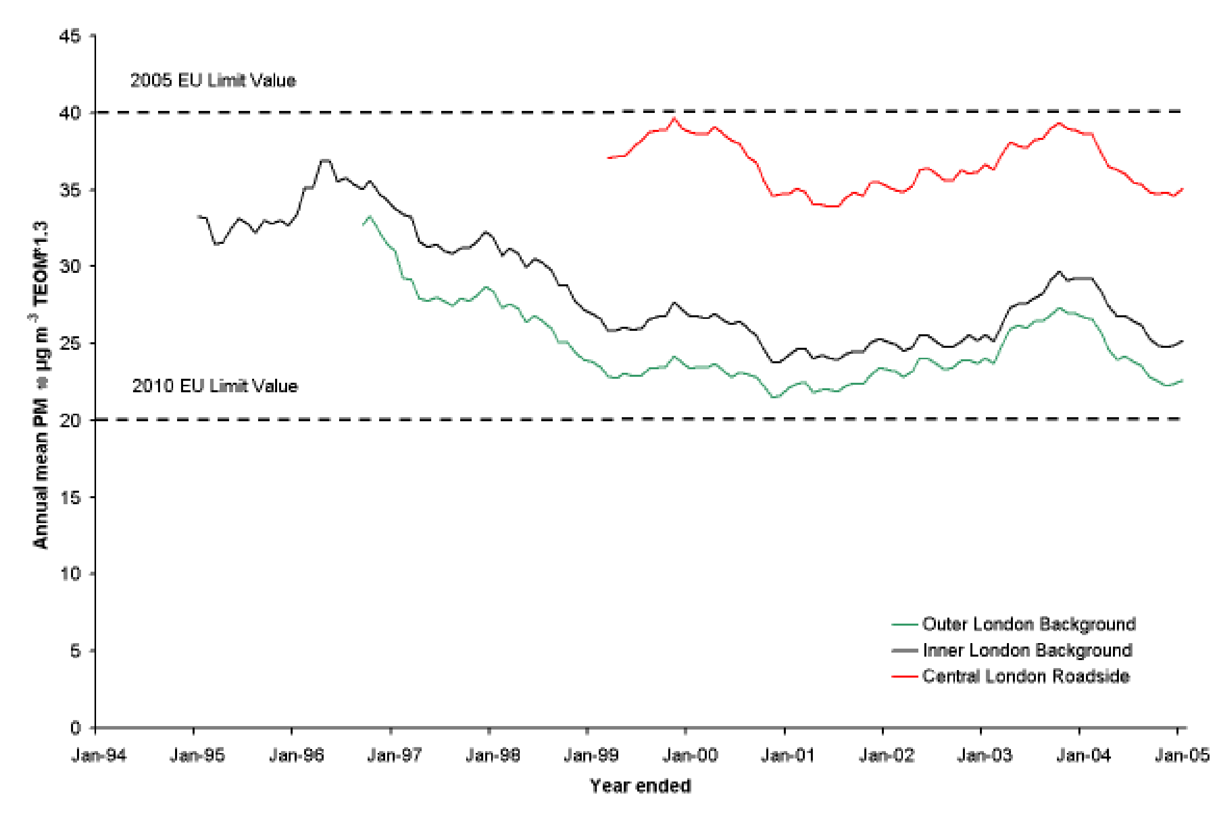
A puzzle…….



2005 EU Limit Value
2010 EU Limit Value
Annual mean PM 10 µg m -3 TEOM*1.3
Year ended
Outer London Background
Inner London Background
Central London Roadside
45
40
35
30
25
20
15
10
5
0
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

Source apportionment method

Total PM10 = primary + non primary

– *Primary is related to NOX and is local*

– *Non – primary is not related to NOX and is regional*

(Same approach can also be taken with PM2.5)

Deacon et al., 1997; Harrison et al., 1997; APEG, 1999; Kukkonen et al., 2001 and Stedman et al., 2001, Fuller et al. 2002 and Fuller and Green 2006.

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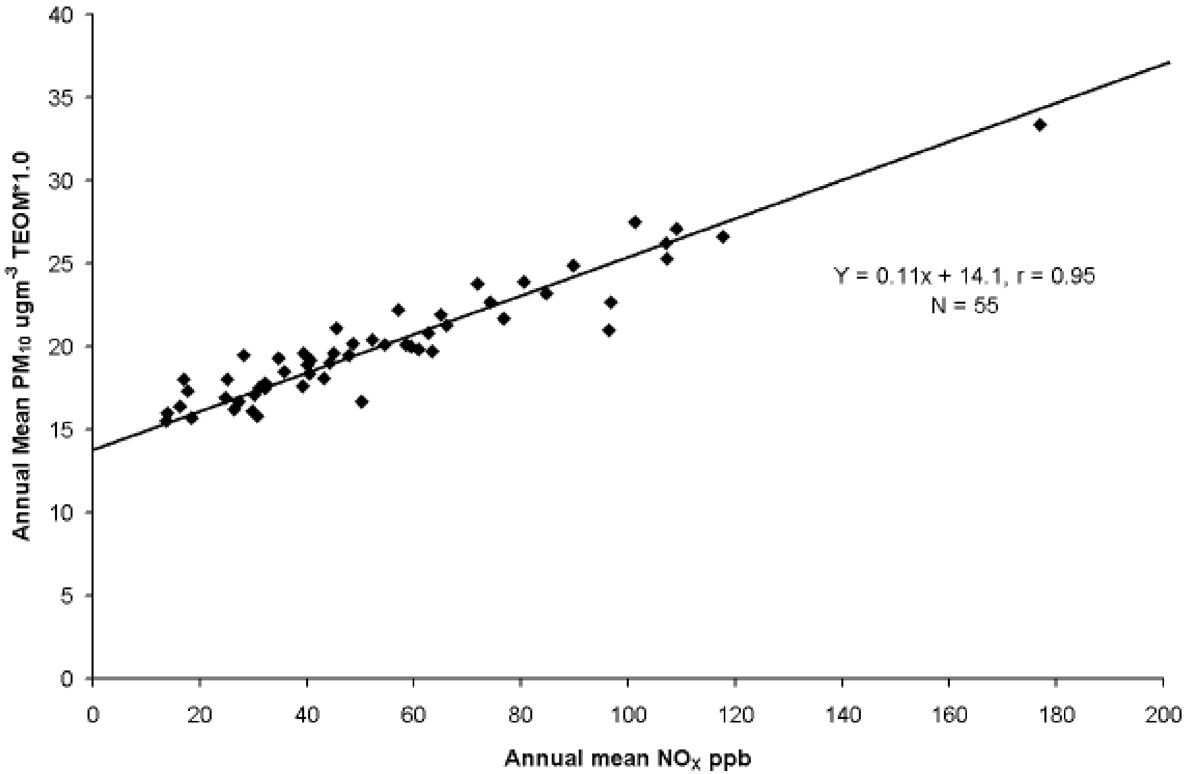
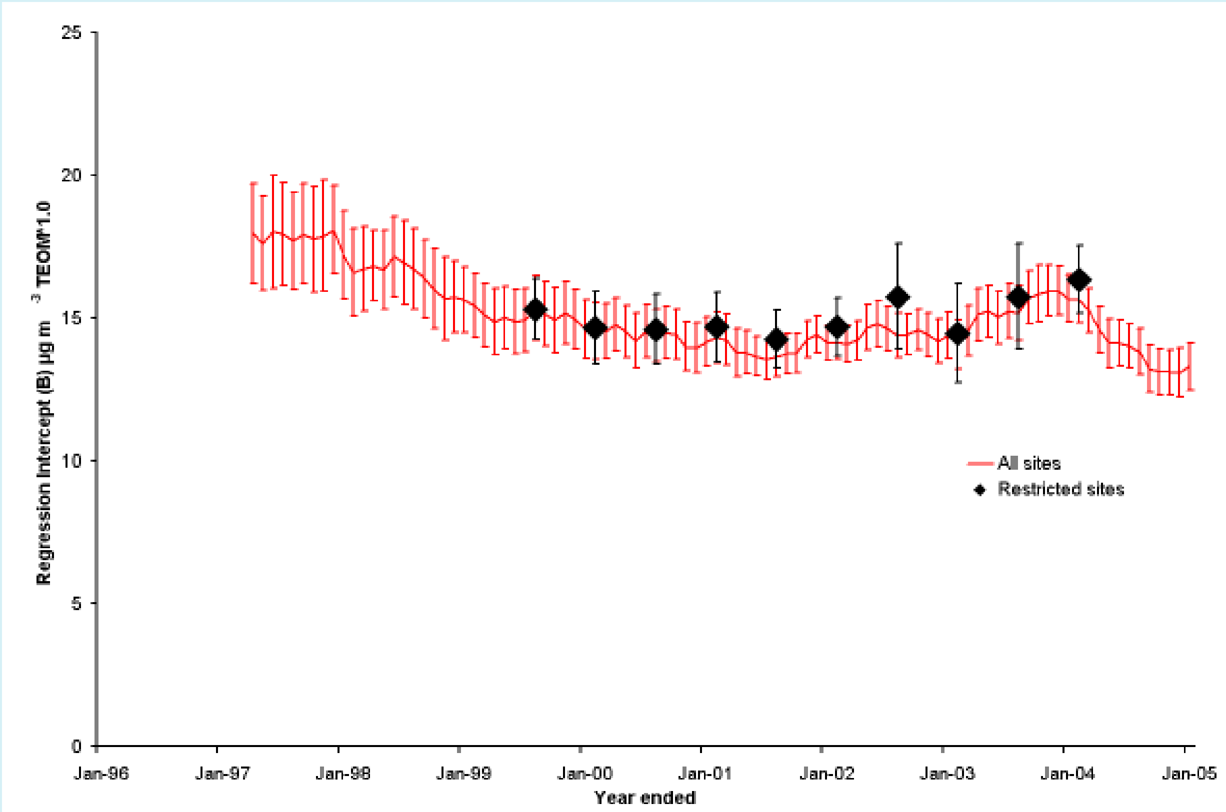
Source apportionment method

Annual mean 2001



Source apportionment method

Intercept B changes in time



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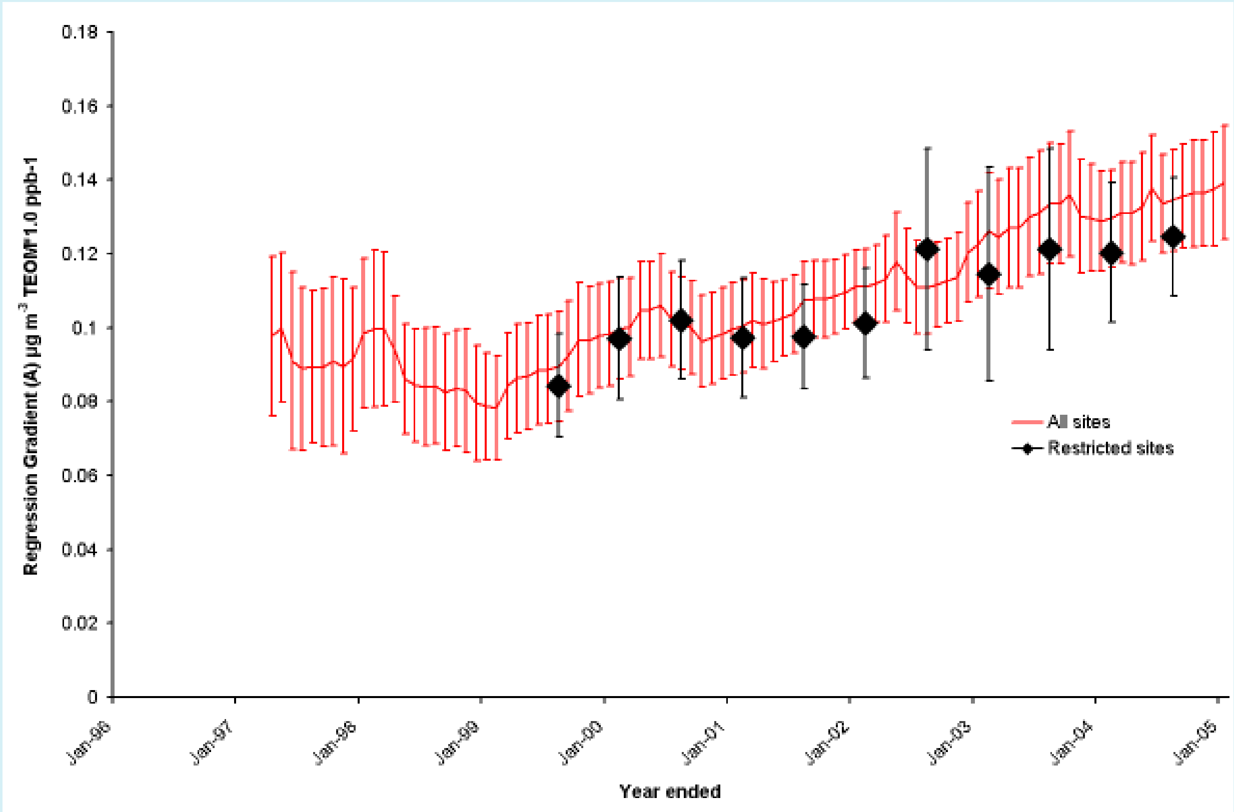
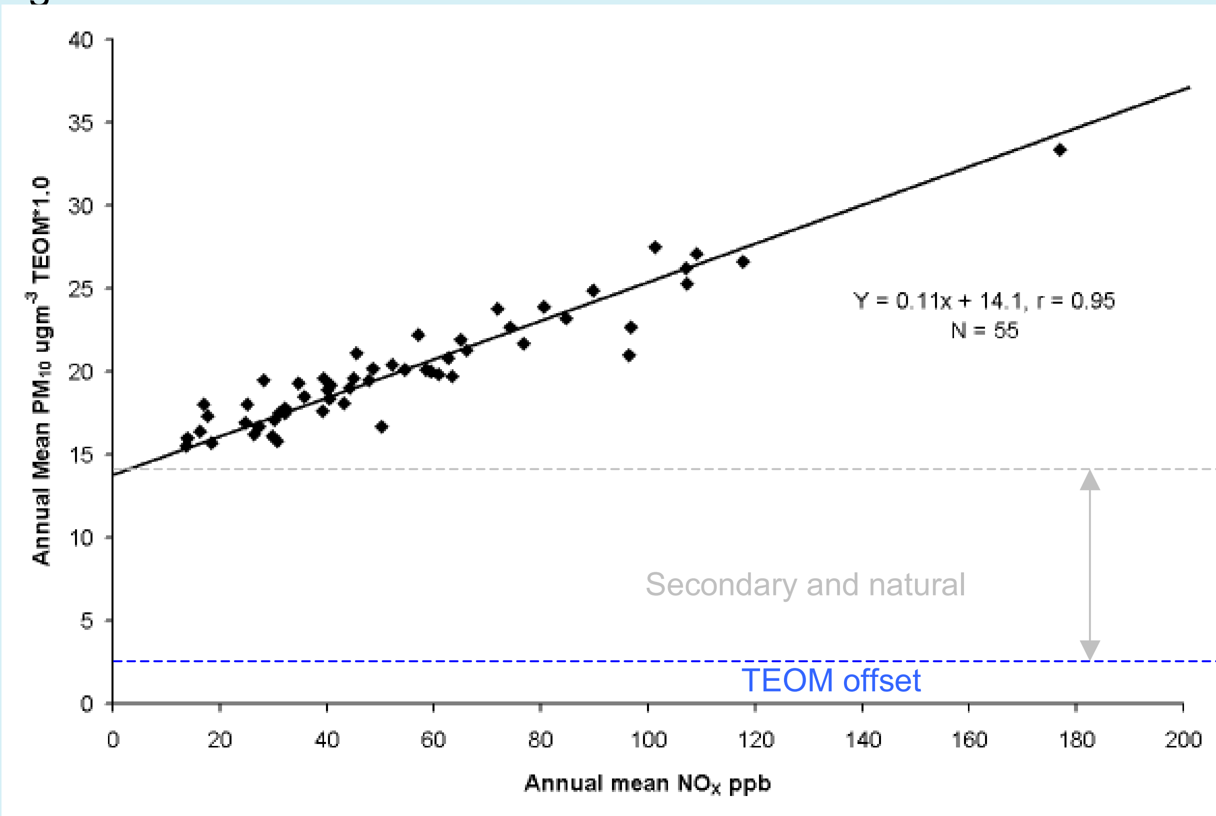
Source apportionment method

Gradient A changes in time



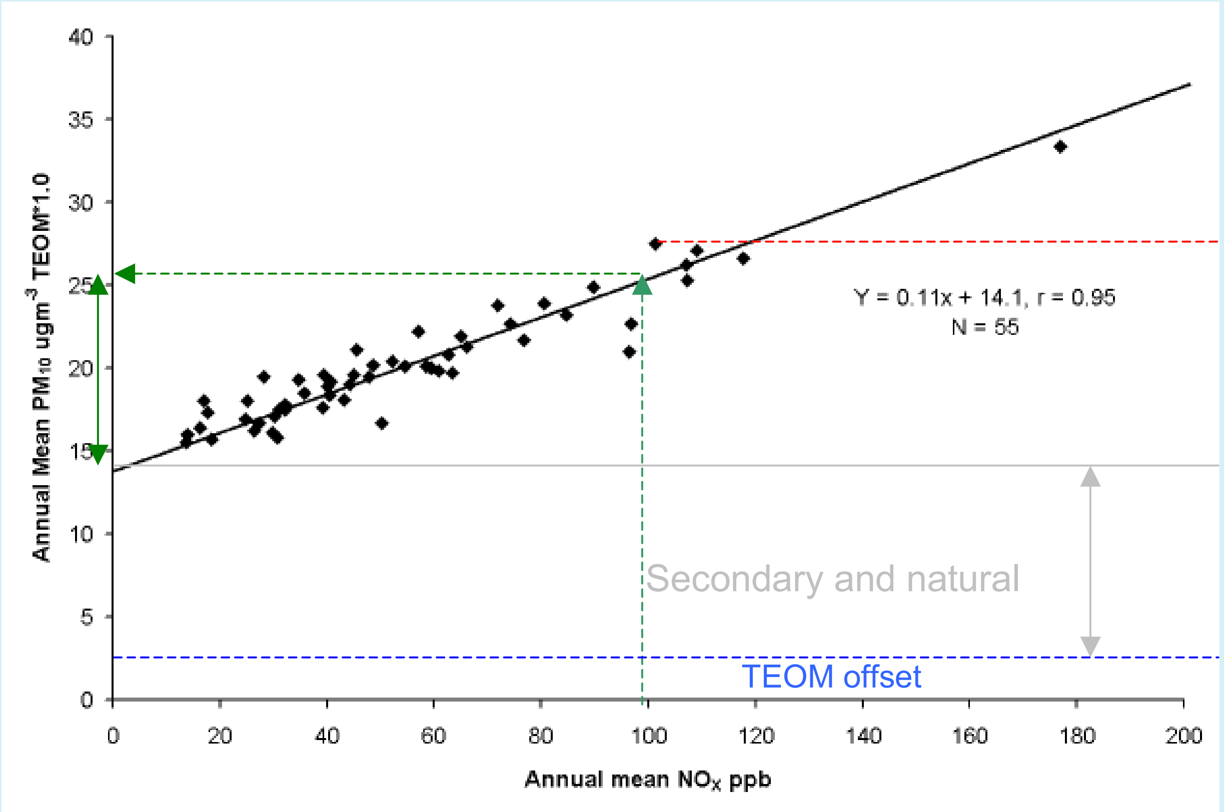
Source apportionment method

Annual mean 2001 – calculating the secondary and natural background



Source apportionment method

Annual mean 2001 – calculating the primary PM10



Calculating primary PM10

Given that we have a relationship $[PM_{10}] = A\ [NO_X] + B$

3 methods to calculate primary PM_{10} $PM_{10}(P)$

$PM_{10}(P) = [PM_{10}] – B$
$PM_{10}(P) = A[NO_X]$
$PM_{10}\ (P) = ([PM_{10}] – B + A[NO_X])/2$

Used uncertainty estimates (GUM) to determine which is best

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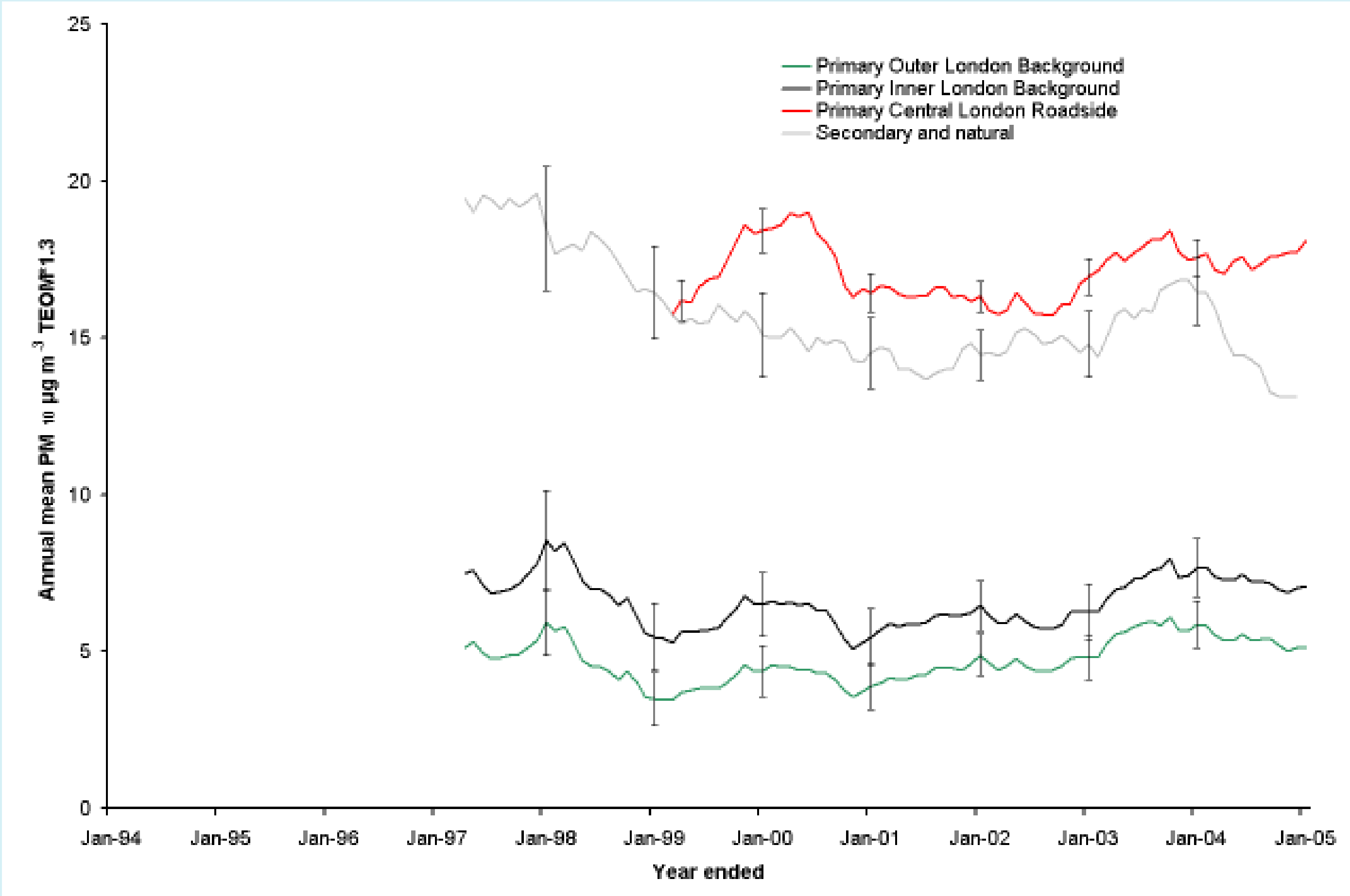
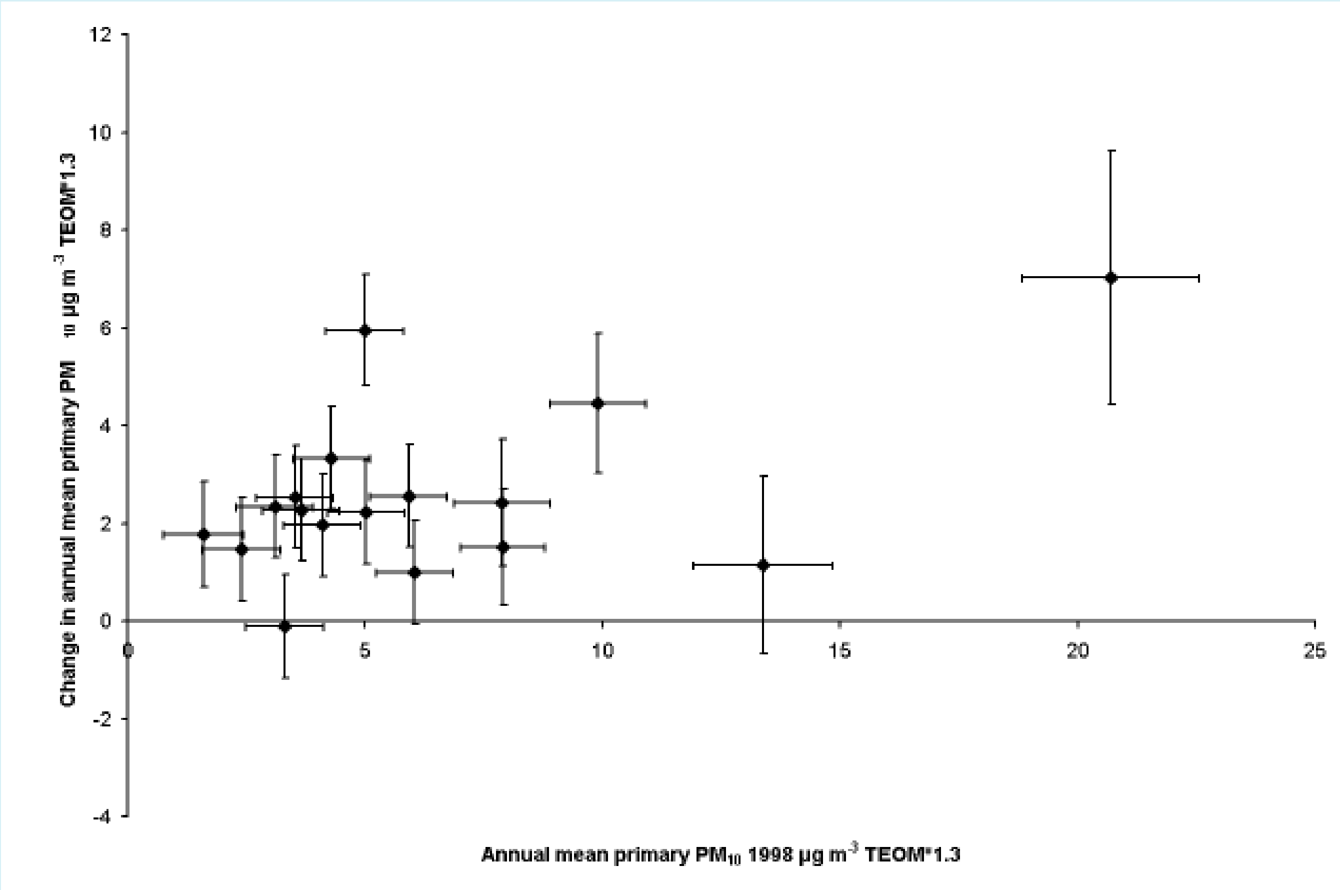
Source apportionment of annual mean concentrations



Change in annual mean primary PM10 1998 - 2003

Site	Type	London Area	All sites Change	Concentration
			µg m^{-3} TEOM *1.3	
Marylebone Road	K	Central	7.0 ± 2.6	27.7 ± 1.8
Wandsworth 4	R	Inner	6.0 ± 1.1	10.9 ± 0.8
Ealing 2	R	Outer	4.5 ± 1.4	14.4 ± 1.0
Thurrock 1	B	Outside	3.3 ± 1.1	7.6 ± 0.7
Tower Hamlets 1	B*	Inner	2.6 ± 1.1	8.5 ± 0.7
St Albans	B	Outside	2.5 ± 1.0	6.1 ± 0.7
Hillingdon 1	R	Outer	2.4 ± 1.3	10.3 ± 0.8
Brent 1	B*	Outer	2.3 ± 1.0	5.4 ± 0.7
Bexley 2	B	Outer	2.3 ± 1.1	5.9 ± 0.7
Kens & Chelsea 1	B*	Inner	2.2 ± 1.1	7.2 ± 0.7
Bexley 1	B*	Outer	2.0 ± 1.0	6.1 ± 0.7
Medway Stoke	Ru	Outside	1.8 ± 1.1	3.4 ± 0.7
Haringey 1	R	Outer	1.5 ± 1.2	9.4 ± 0.8
Mole Valley 2	B	Outside	1.5 ± 1.1	3.9 ± 0.7
A3 Roadside	R	Outer	1.1 ± 1.8	14.5 ± 1.1
Chatham	B	Outside	1.0 ± 1.1	7.0 ± 0.7
Sevenoaks	B	Outside	-0.1 ± 1.1	3.2 ± 0.7

Change in annual mean primary PM10 1998 - 2003



Primary PM10 should be reducing !

- *Emission inventories say it should be reducing*
- *Tail pipe abatement on new vehicles and London's buses*

But

- *Diesels = 16% new cars in 1997 cf 38% in 2006 (SMMT 2006) but this should not offset new Euro Standards (AQEG 2006).*
- *No trend in black smoke concentrations in London but trends in rest of UK (AQEG 2006).*
- *Vehicles are getting heavier, 30% increase in last 30 years therefore increase non-tailpipe emissions (Carslaw 2006).*
- *Tyre and brakes technologies have changed (Boulter 2006)*

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Chemical composition of source apportioned components

Limited robust measurements of chemical composition of PM_{10} in London.

DEFRA networks have poor C and no means of separating volatile and non – volatile nitrate

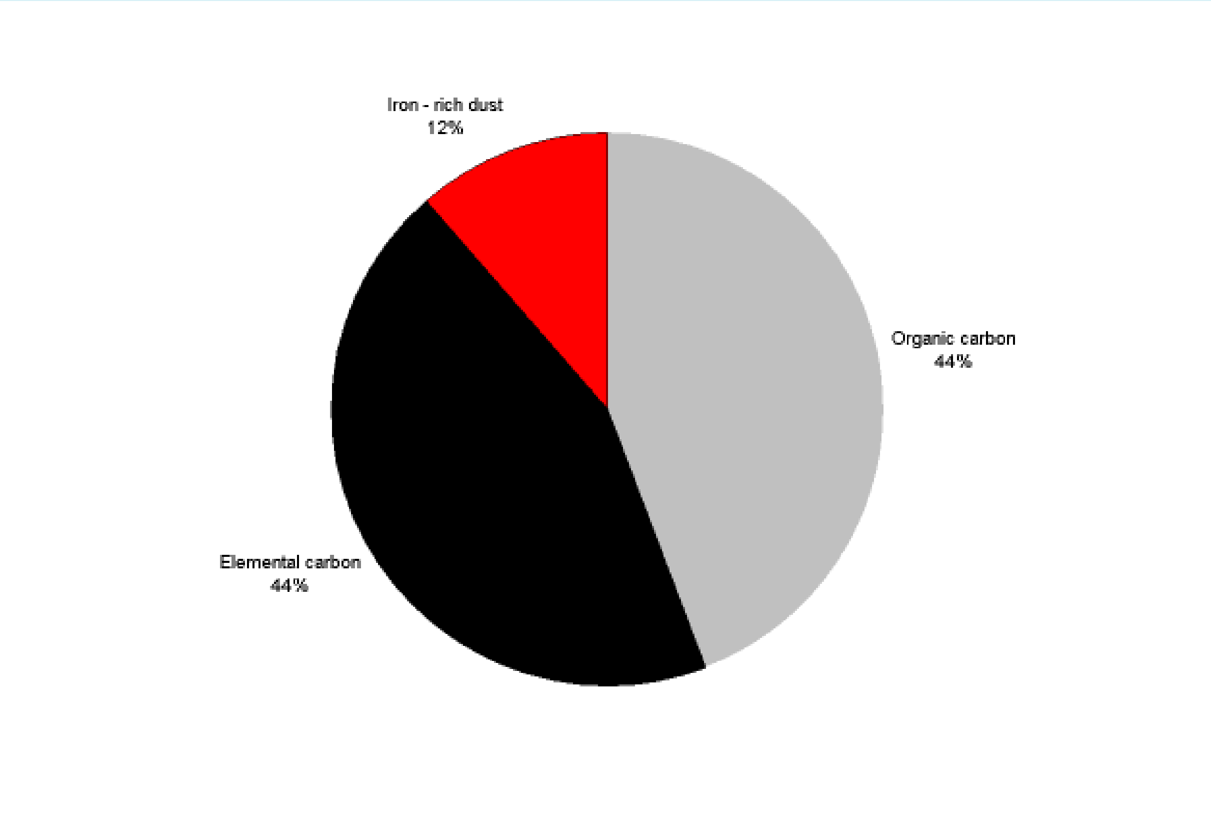
Used measurements from Ealing 2 roadside site during 2001 – 2002

- *PM2.5 carbon measurements from Smith et al 2006 (thanks to DRI)*
- *Anion measurements from Davy 2006*

Also methods and measurements from Harrison et al 2003, 2004 sites in London and Birmingham 2000 - 2002

Chemical composition (~2000 – 2002)

Primary PM10



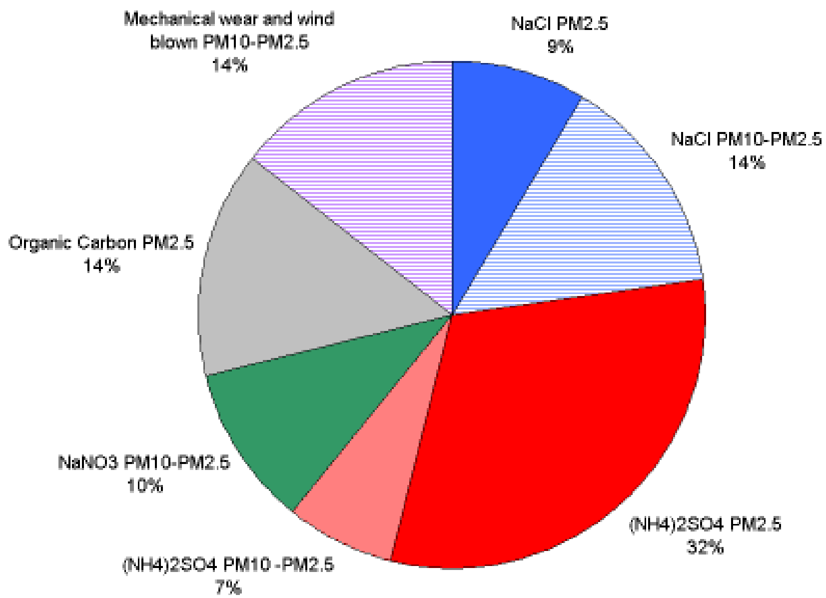
Chemical composition (~2000 – 2002)

Primary PM10

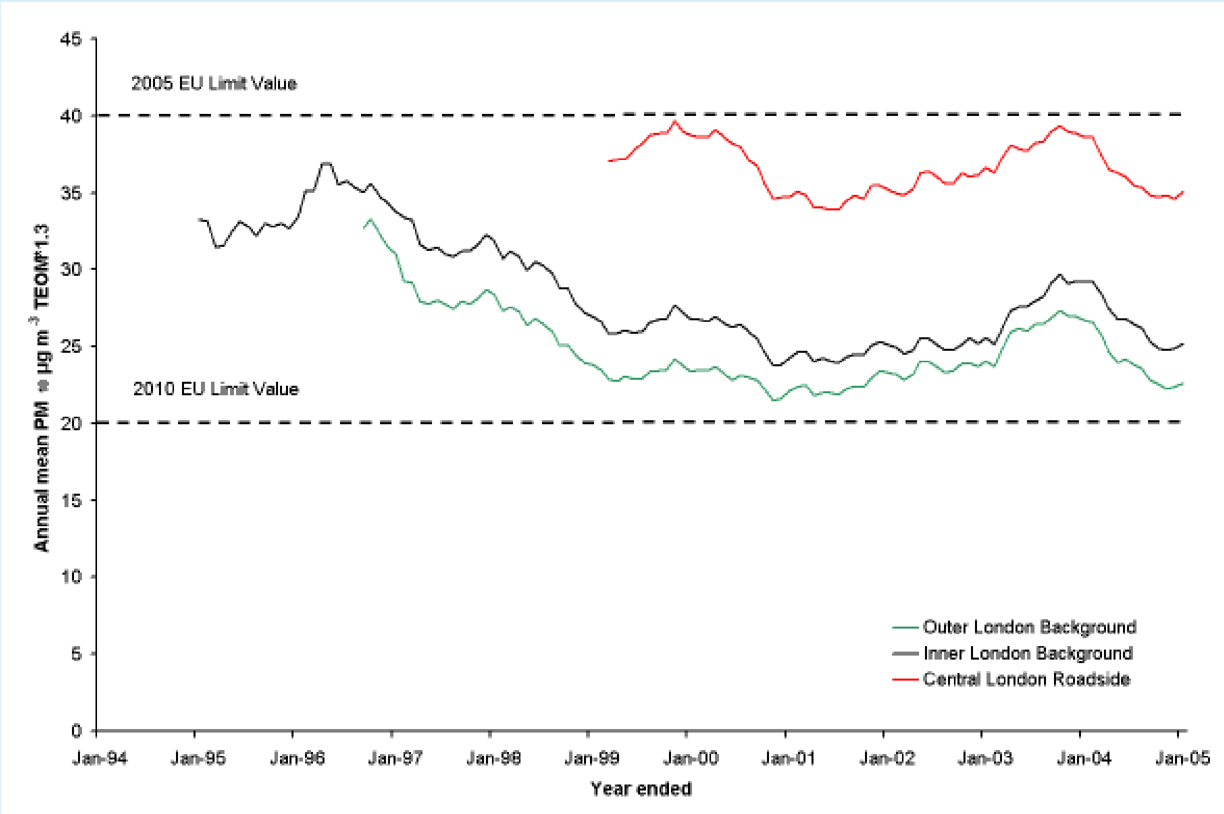
	$PM_{2.5}$	PM_{10}-$PM_{2.5}$	PM_{10}
Organic carbon	50%	18%	44%
Elemental carbon	50%	18%	44%
Mechanical wear / Iron- rich dust		64%	12%
Total	**100%**	**100%**	**100%**

Chemical composition

Non primary PM10 (TEOM measurements!)



Back to the puzzle…….

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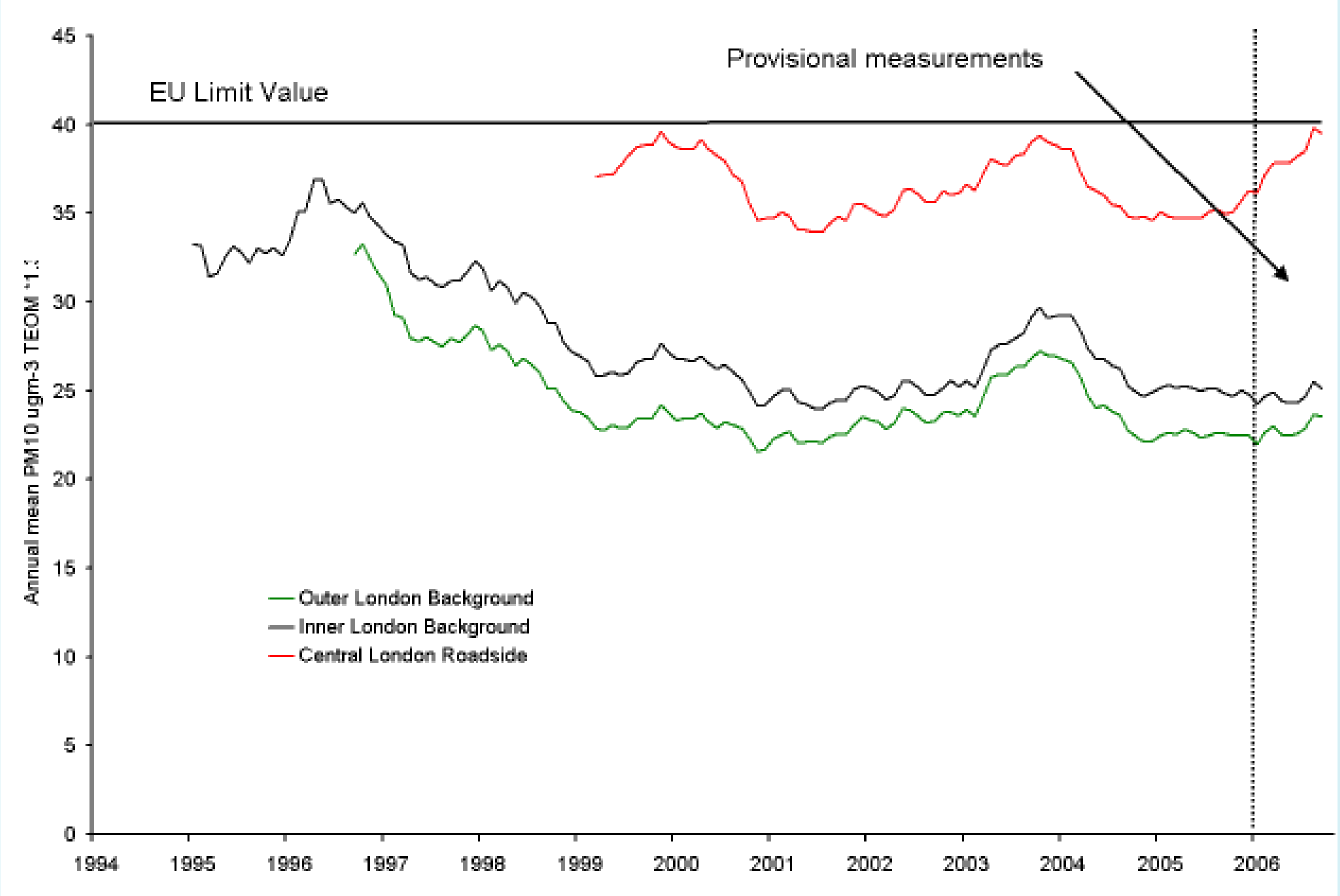
An update…


Provisional measurements
EU Limit Value
Annual mean PM10 ugm-3 TEOM *1.3
45
40
35
30
25
20
15
10
5
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Outer London Background
Inner London Background
Central London Roadside

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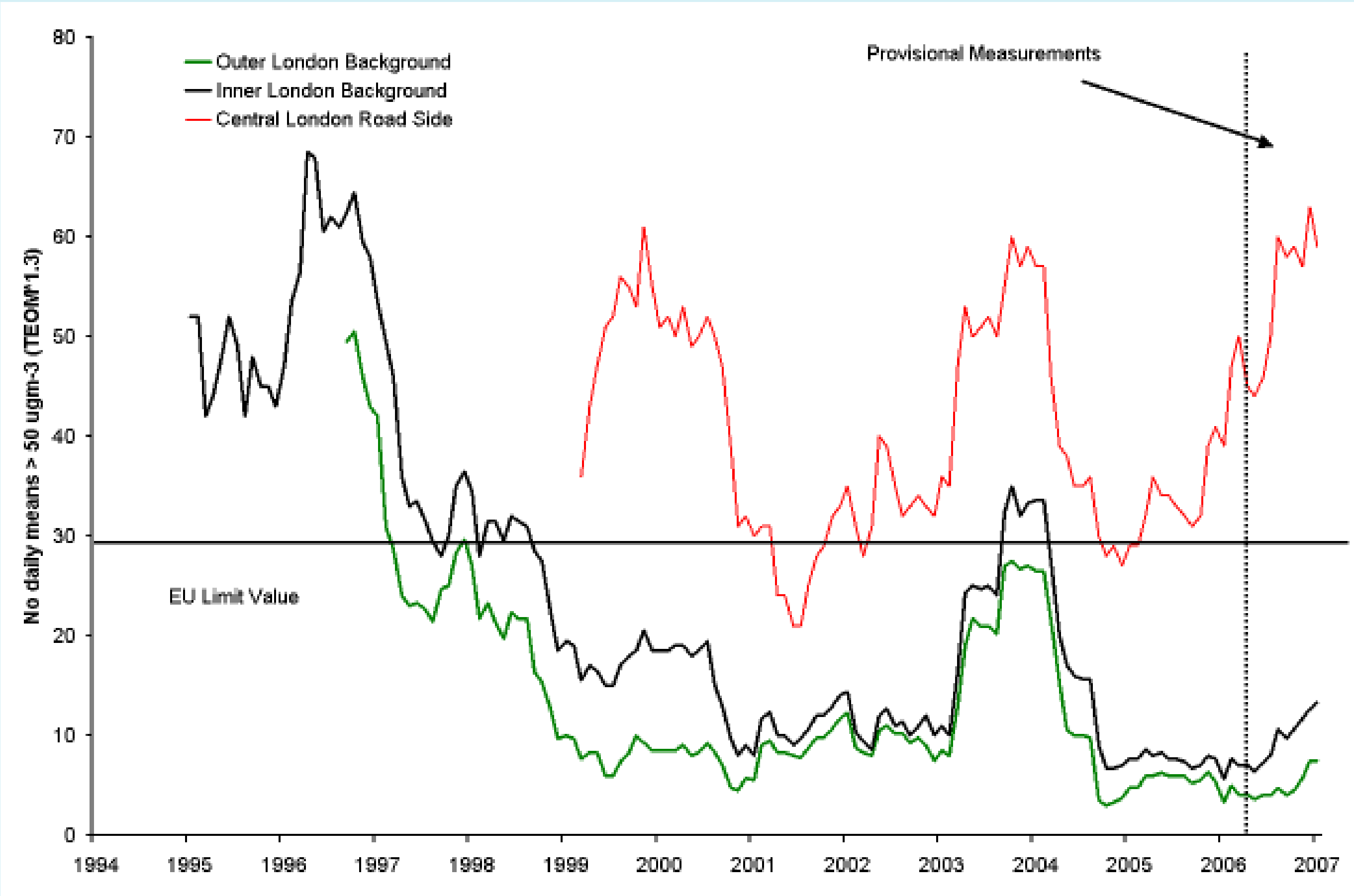
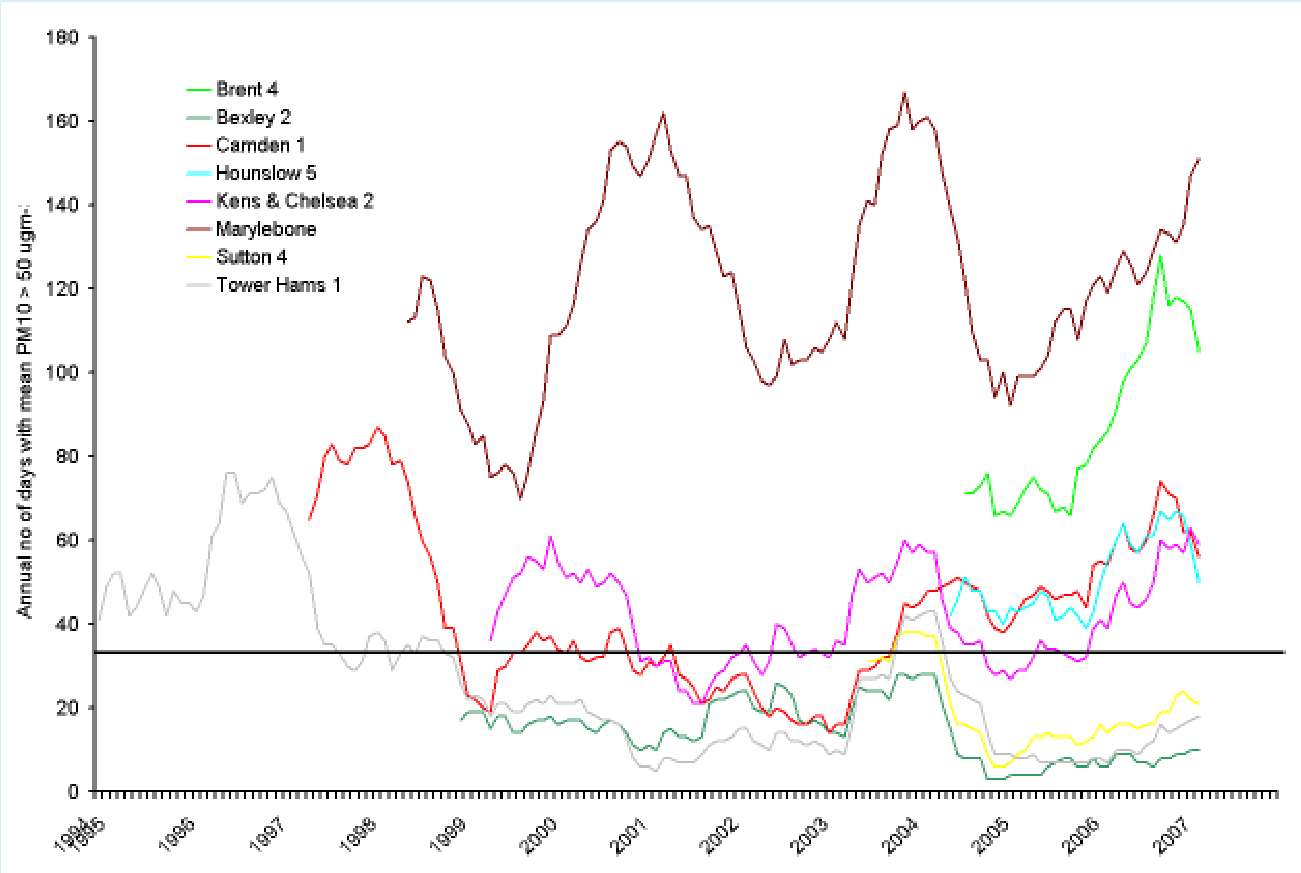
An update…



An update…



Brent 4
Bexley 2
Camden 1
Hounslow 5
Kens & Chelsea 2
Marylebone
Sutton 4
Tower Hams 1
Annual no of days with mean PM10 > 50 ugm-
180
160
140
120
100
80
60
40
20
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

Conclusions – Non primary PM10

May indicate reduced emissions of secondary pre-cursers.

But

- *Changes are within model uncertainty*
- *Barely sensitive to particulate nitrate*

Conclusions – Primary PM10

Primary PM10 concentrations in London are increasing which has important implications for air quality management.

Source apportionment and recent measurements point to a roadside effect.

Contrasts with emission inventory predictions.

Confounded but not explained by weather.

Would require huge increases in non – exhaust PM10 for this to counter expected reductions in tail pipe PM10.

Next Steps..

Large increases at specific roadside sites merit further investigation.

- *Fleet composition and traffic patterns*

New source apportionment data is now available

- *CONCAWE*
- *NPL / KCL (DEFRA) carbon measurements*

Interesting artefacts in 'gravimetric' and FDMS measurements

PM2.5?

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Acknowledgements

David Green, Dr. Steve Smith and Pam Davy, KCL

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