Air pollution in London, trends and challenges

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Contents

The current situation and decadal changes in London's air pollution

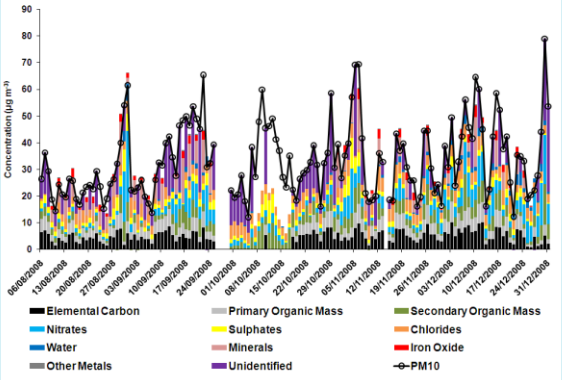
Methods

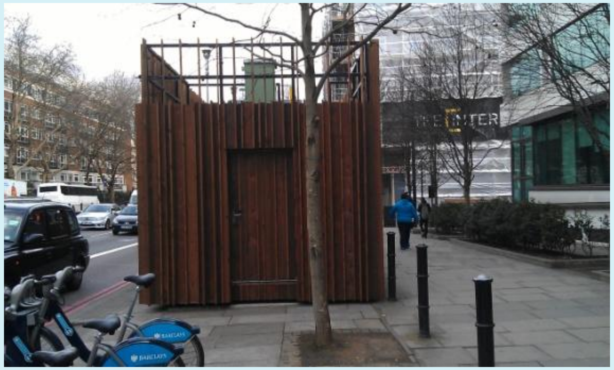
Results for:

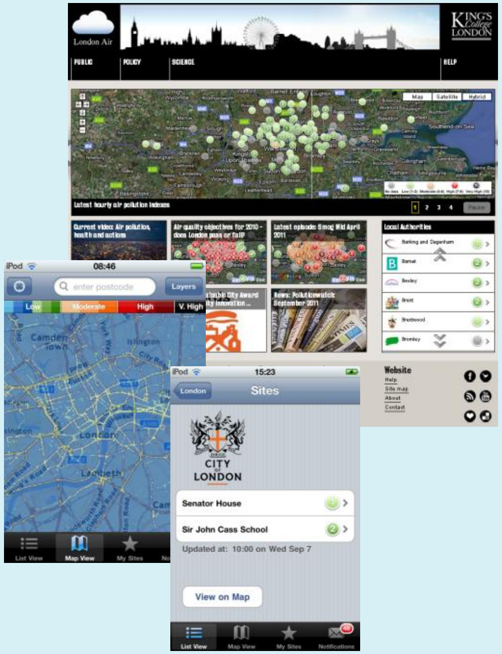
- PM10 and PM2.5
- NOX / NO2
- O3
- CO
- SO2
- Black carbon and particle number.

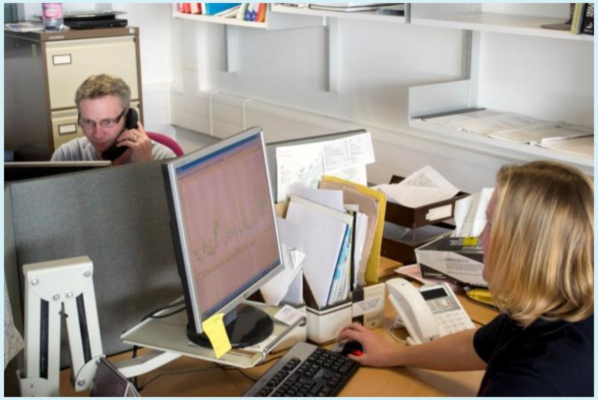
Key issues and challenges

Measuring air pollution in London



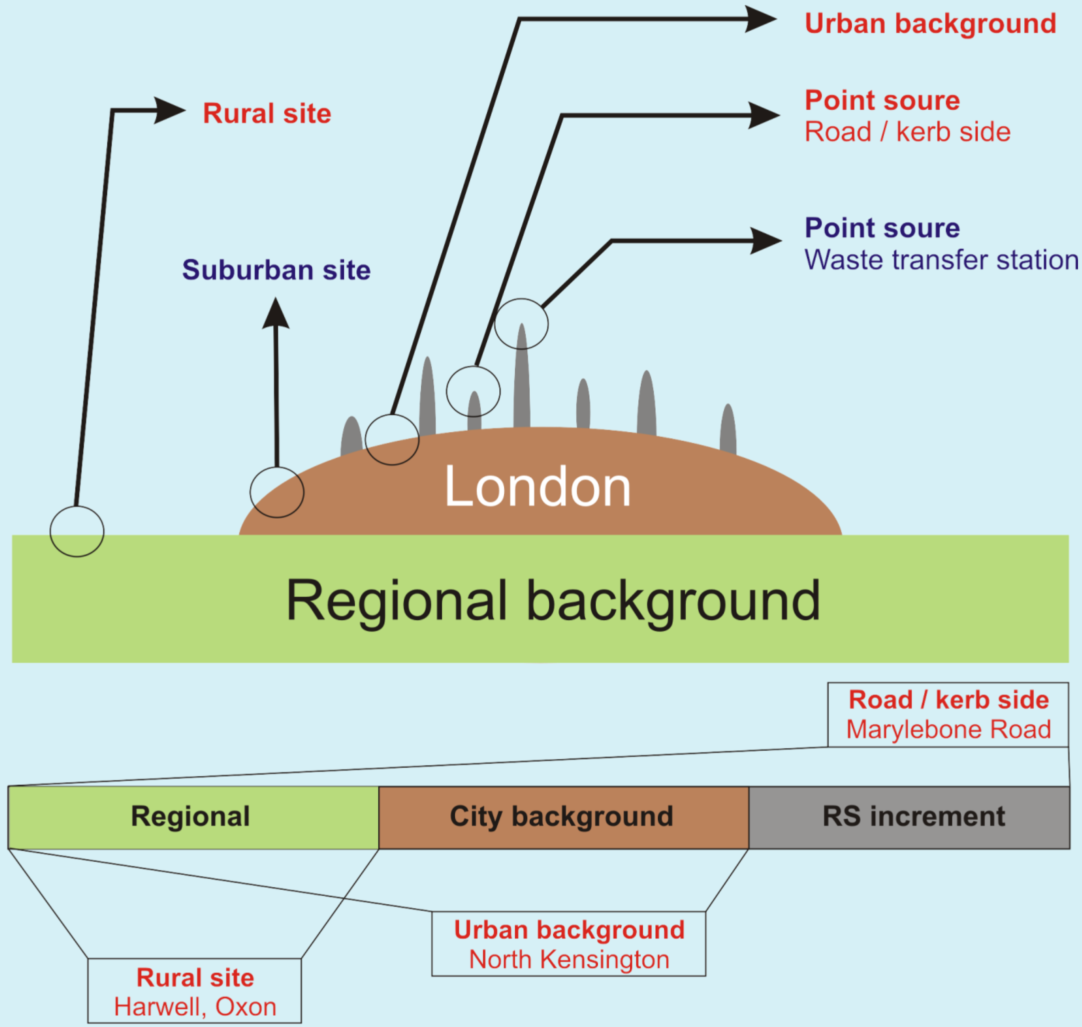






The “Lenschow” perspective

Lenschow et al 2001



Summary data

For each pollutant we have summarised measurements in two ways:

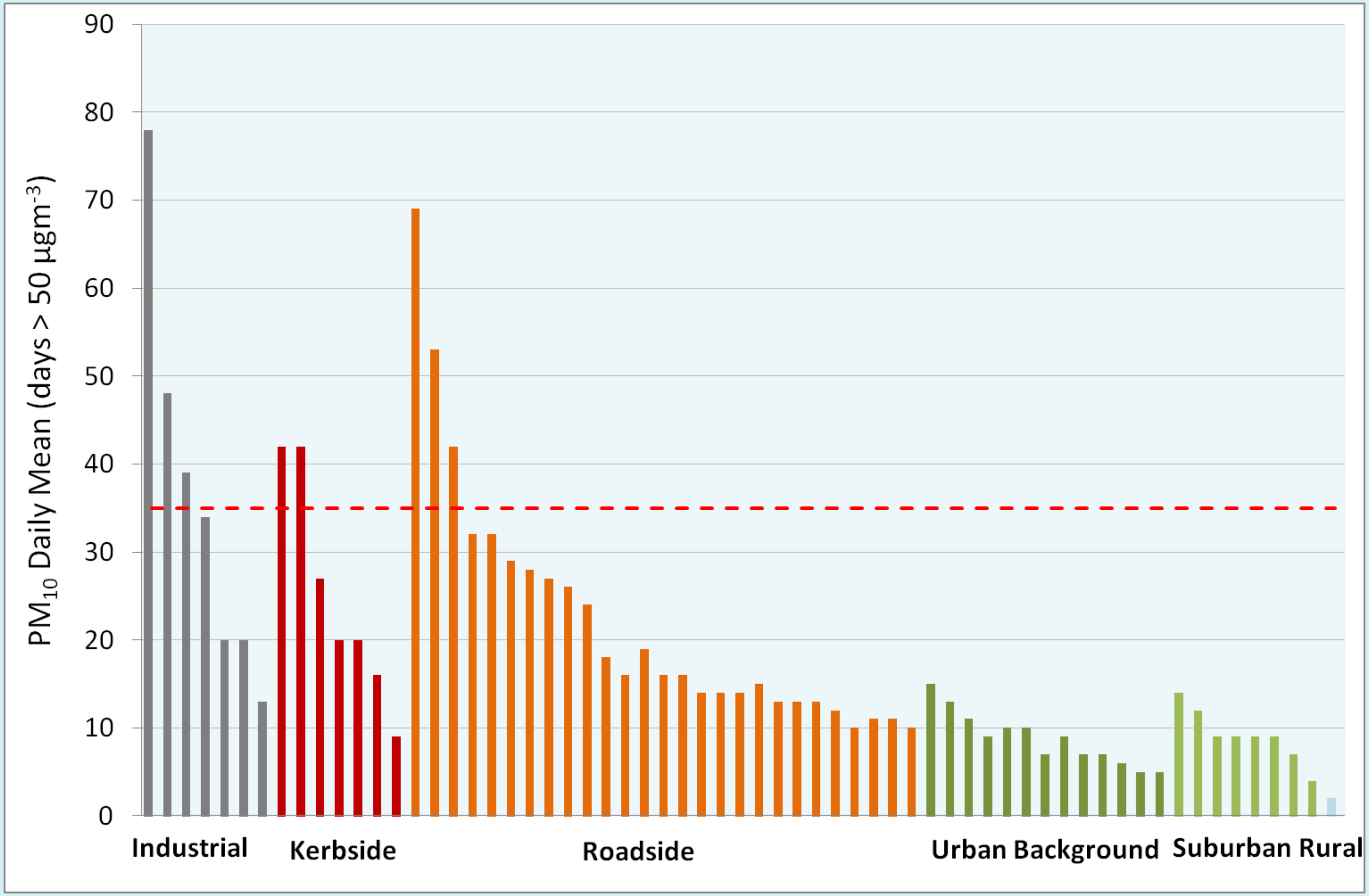
1) 2012 measurements against the AQS Objective / EU LV
2) Trends in long-term measurements sites:
   - Marylebone Road kerbside
   - Inner London roadside
   - Inner London background
   - Outer London roadside
   - Outer London background

Note: assessment of EU LV compliance involves more than just the measurements (esp. for PM.)

EU LV compliance assessment is a Defra responsibility.

PM10

2012 vs the AQS objective / EU LV



PM10 2012 vs the AQS objective

Why did sites exceed?

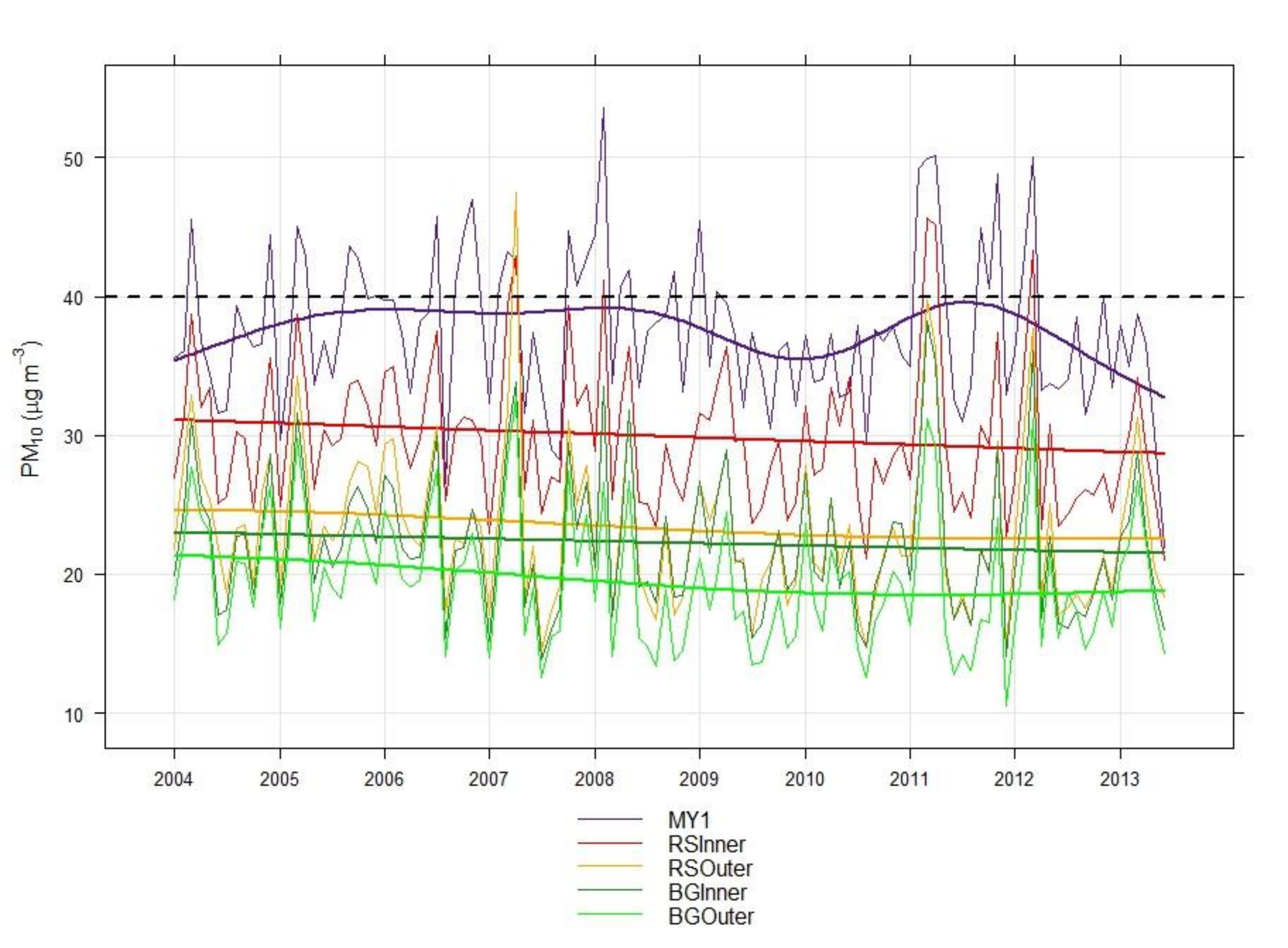
3 sites were close to waste management business

1 site was affected by large scale local construction (Shepherds Bush Green redevelopment)

4 sites alongside busy central London street canyons.

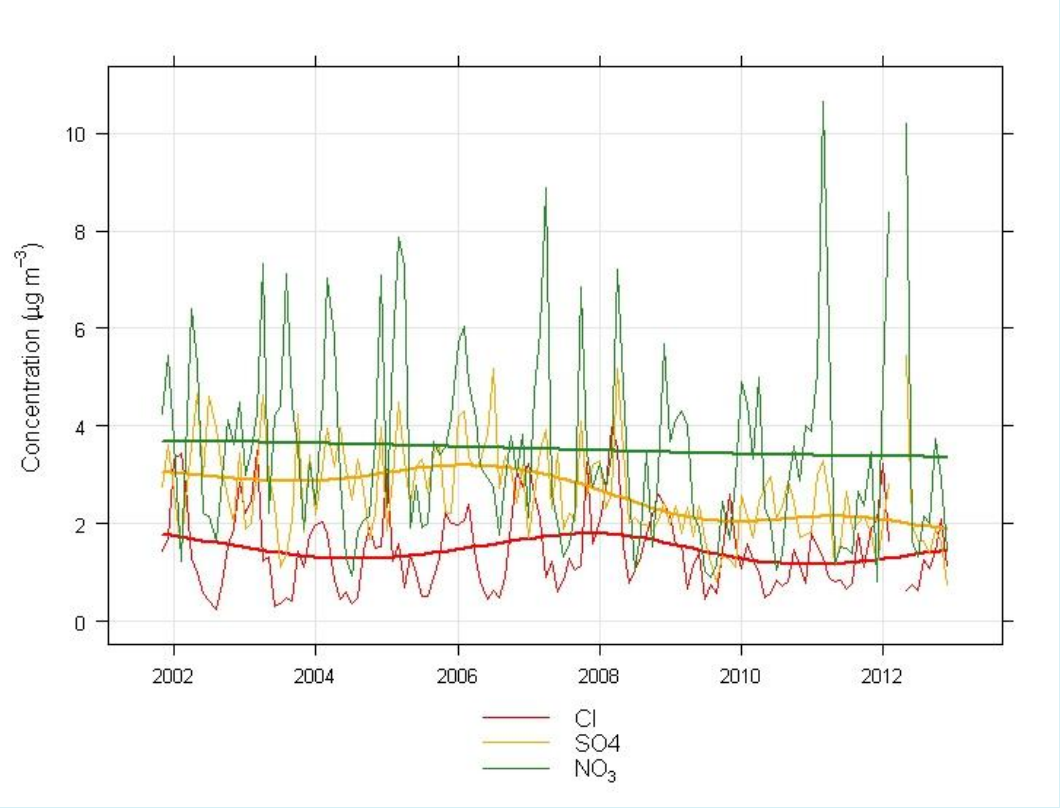
PM10

Trends only possible since 2004 – first date that the VCM could be operated
Probable that changes in the regional background are driving the apparent decrease in PM across site types.



PM10

Regional background NO3 and SO4 decrease 2002 – 2012.
Source apportionment required to determine balance of London and regional changes

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Evidence for increasing concentrations of primary PM_{10} in London

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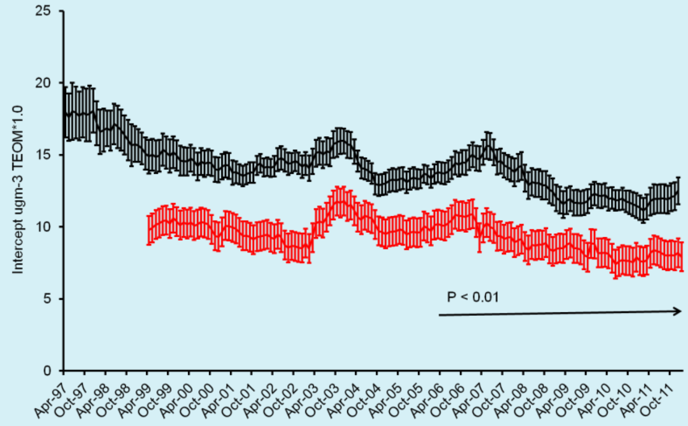
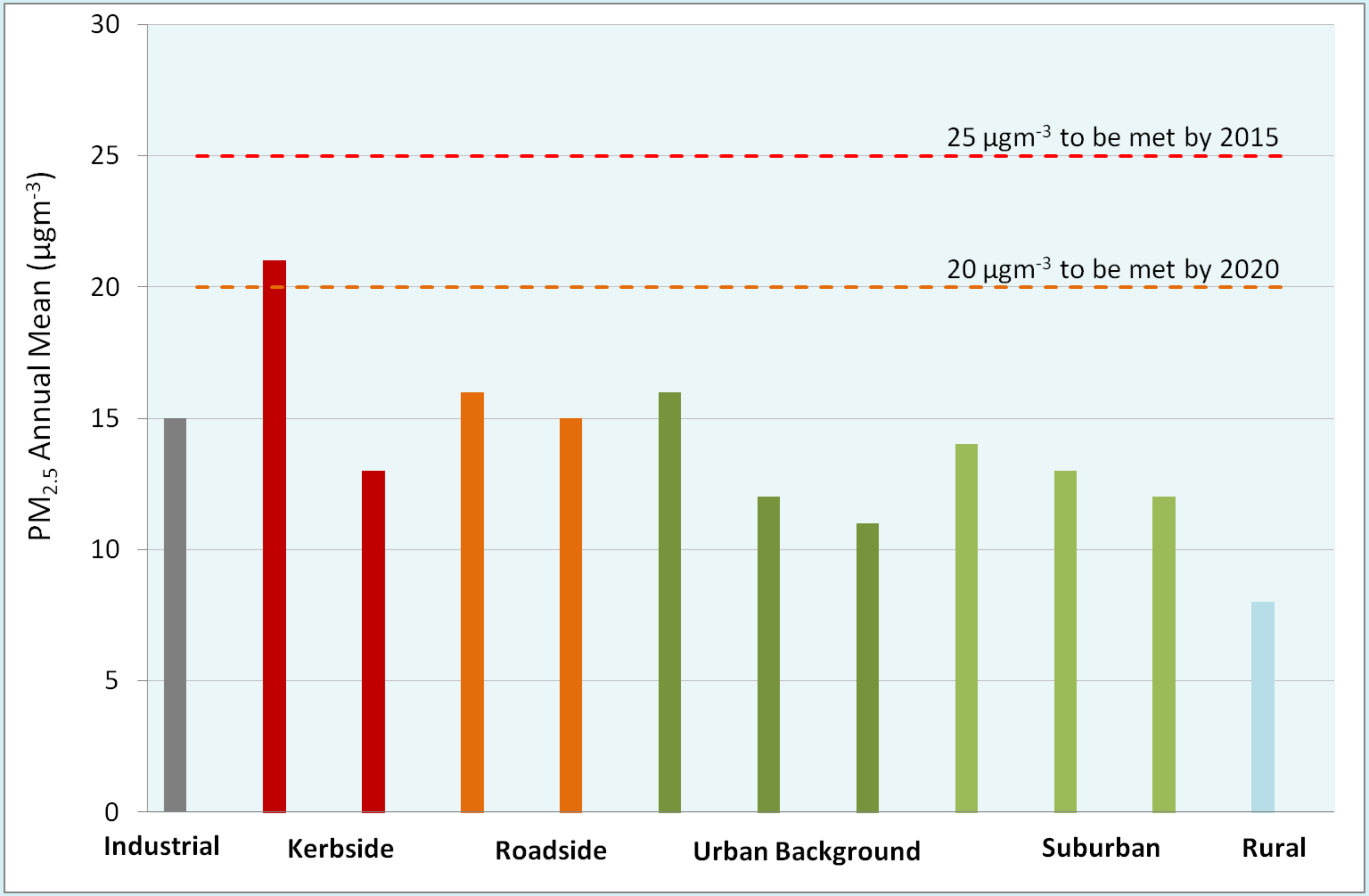


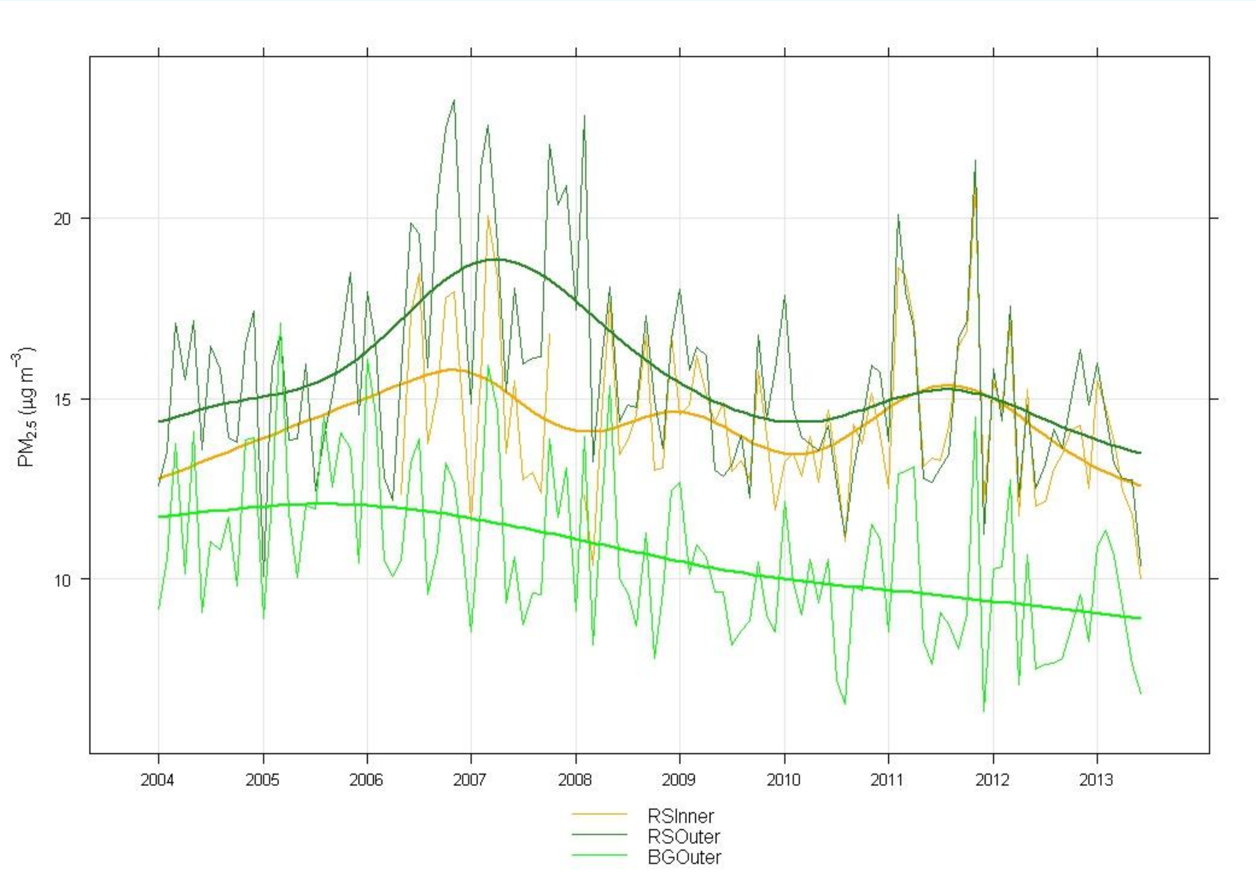
PM2.5

FDMS and partisol measurements only



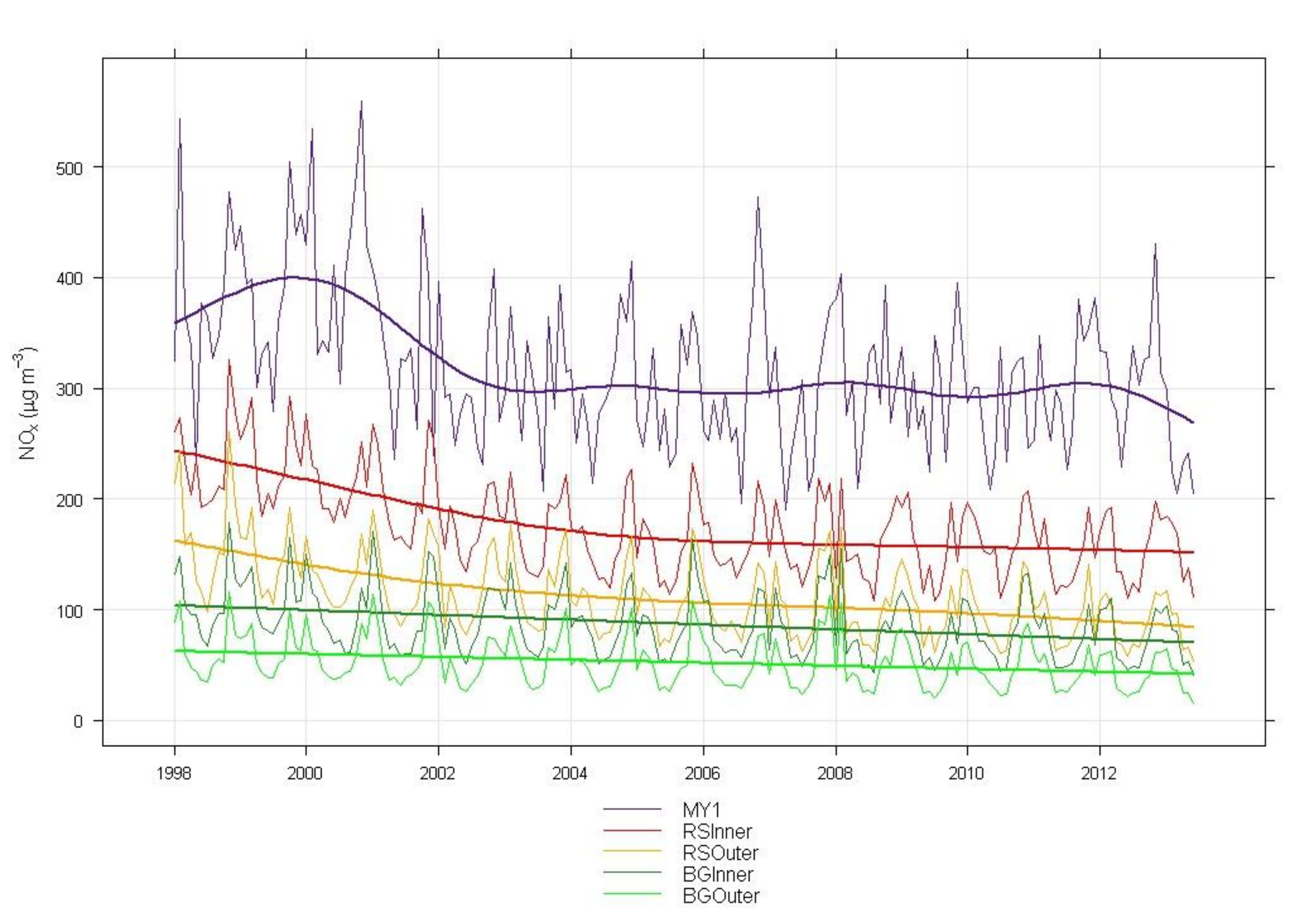
PM2.5

Changes in measurement methods and small numbers of monitoring sites make trends difficult.
TEOM measurement sites only shown



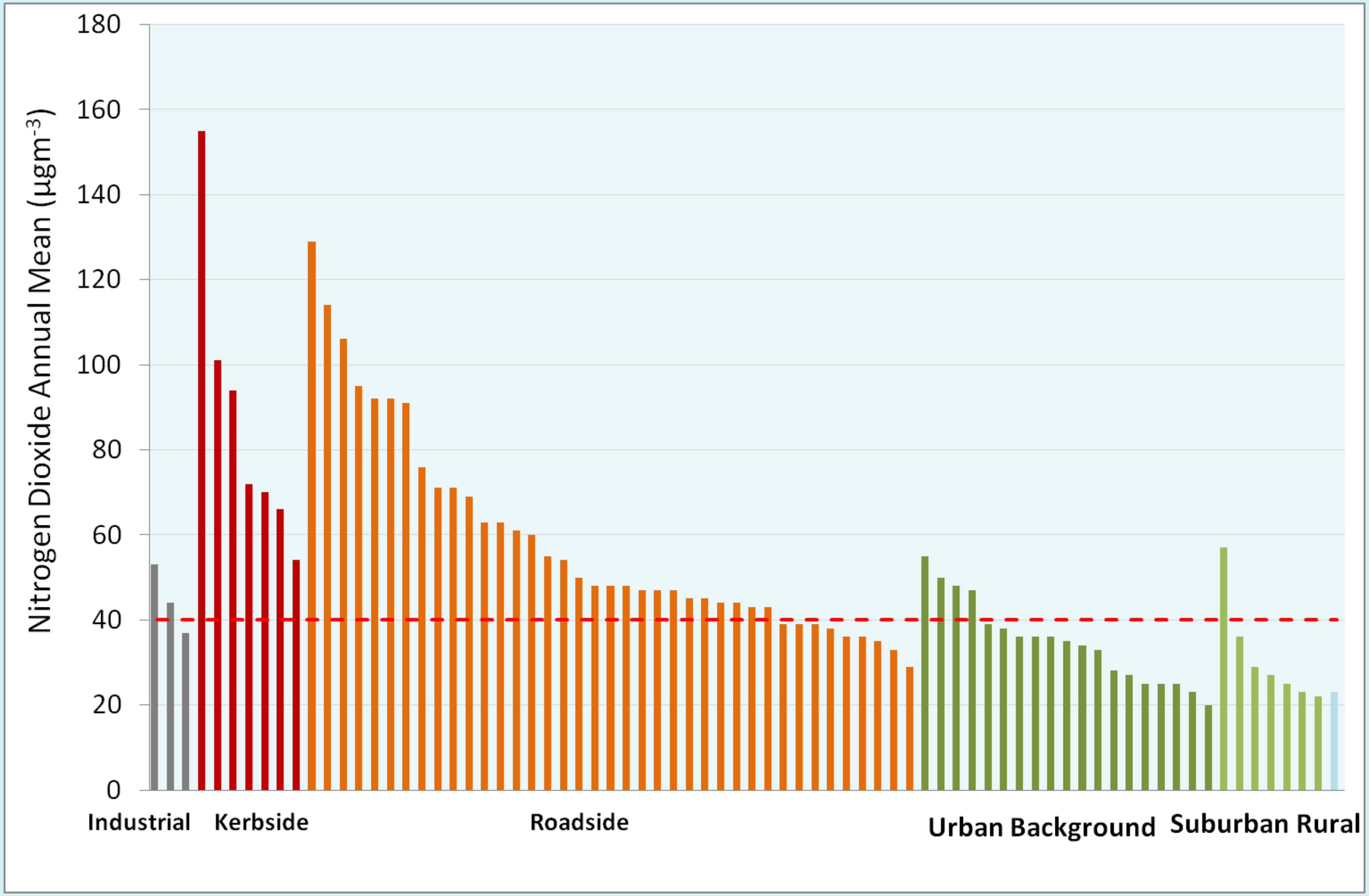
NOX

Primary pollutant (NO+NO2) tells us about emissions related to NO2.
Decreases to ~2002/3 and relative stability since
2013 north- easterlies may have led to decrease at Marylebone Road



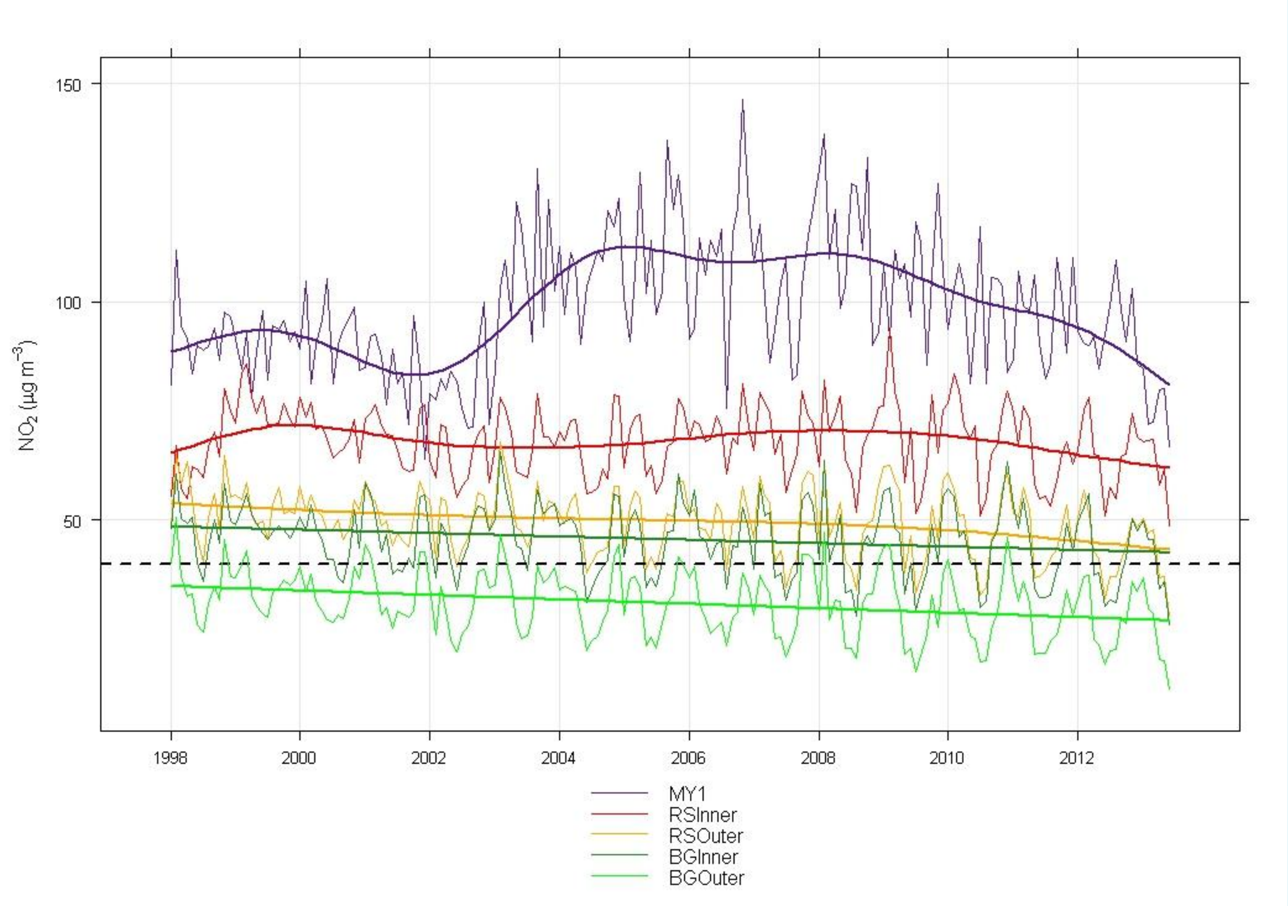
NO2

Widespread breaches of the AQS Objective and EU LV
Some roadside exceed by more than 2-3x



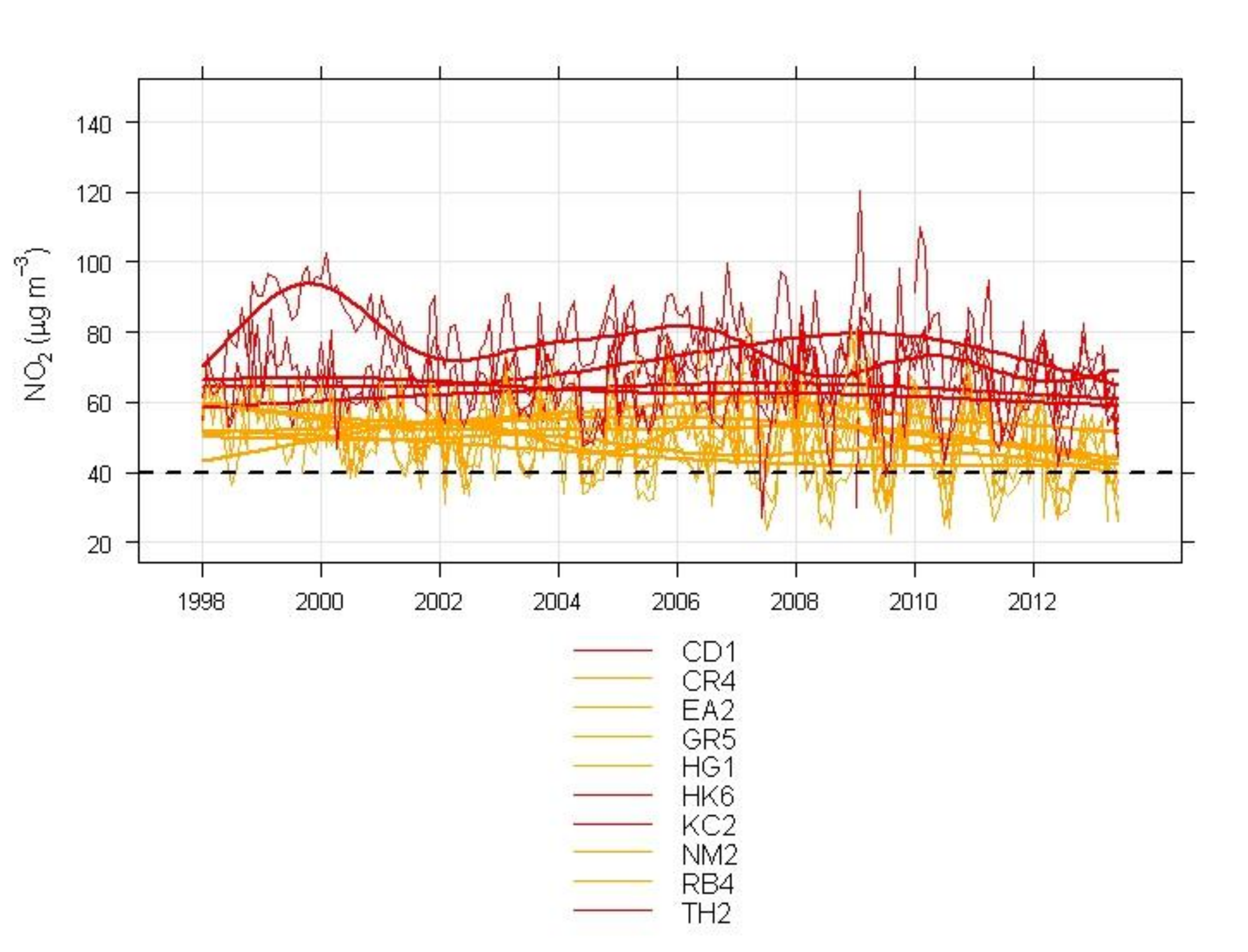
NO2

Decreases in background NO2 not seen close to roads.
Some evidence of a roadside decrease since ~2010
Need to be cautious about recent trends – might be driven by weather conditions.



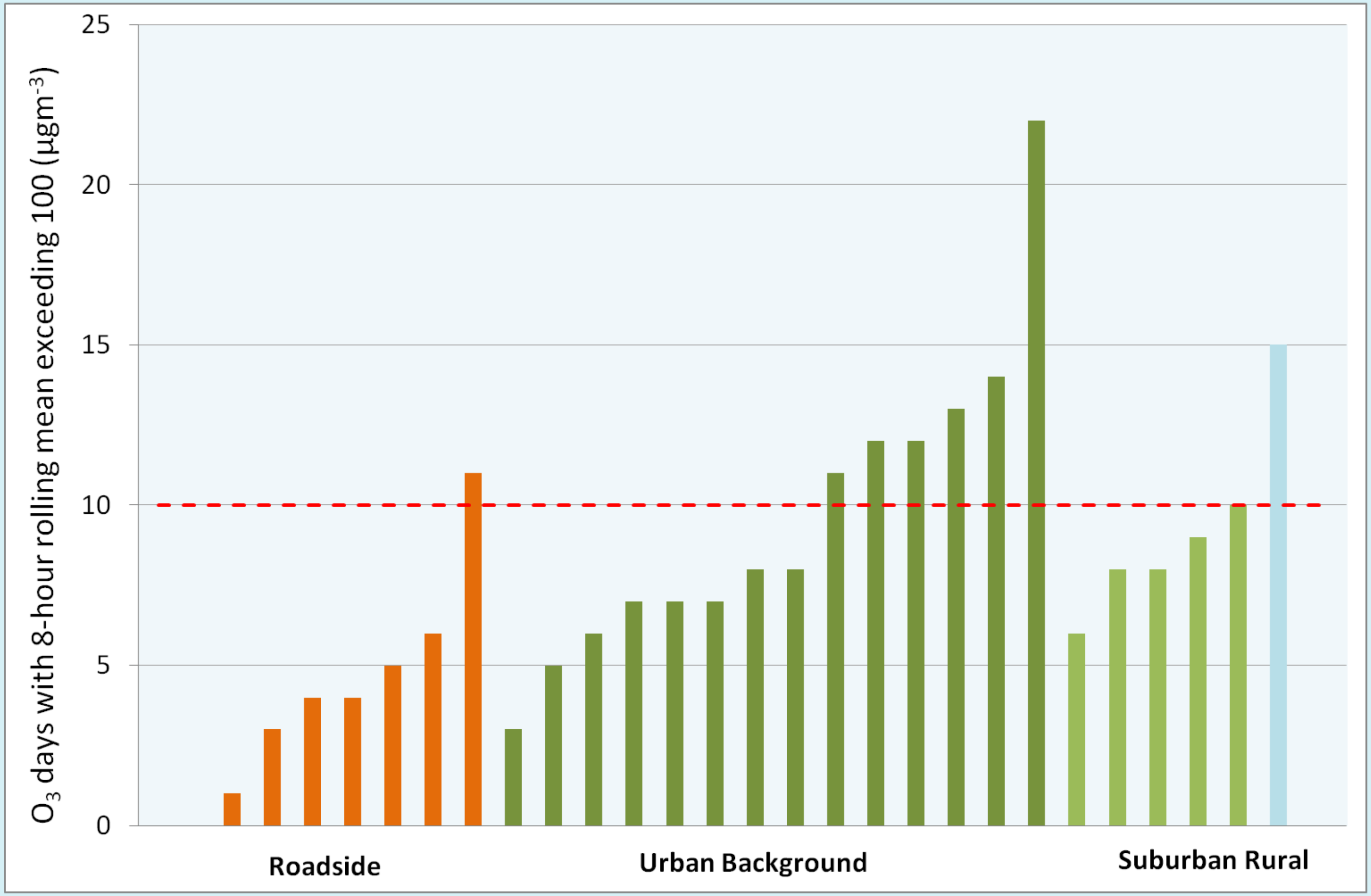
NO2

Variations at different roadside monitoring sites.



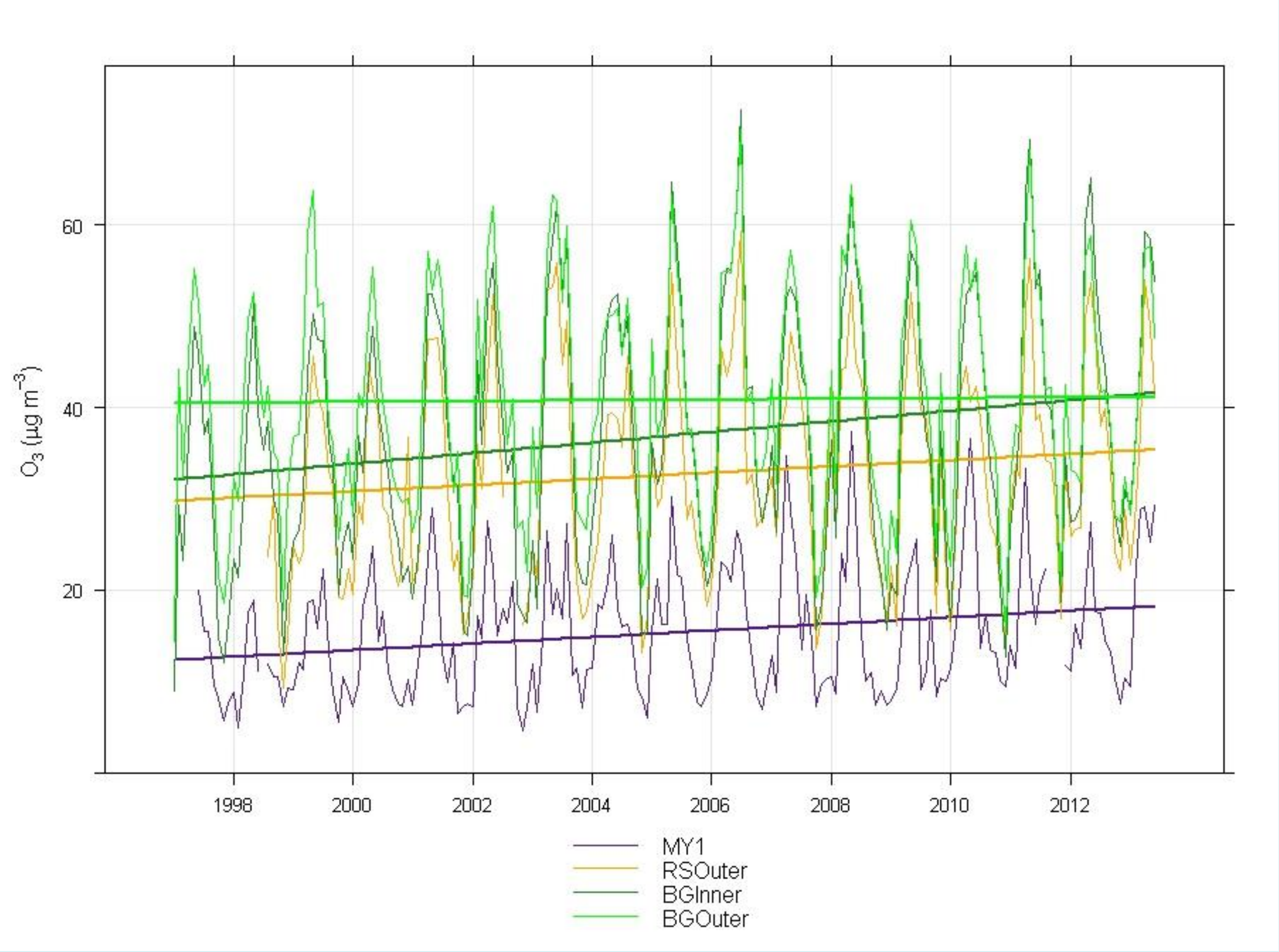
O3

Some breaches of the AQS Objective but not nearly as widespread as previous years. Many sites measured 30 – 40 days with max 8h > 100 ug m-3 in 2008. Reflective of recent “summers”



O3

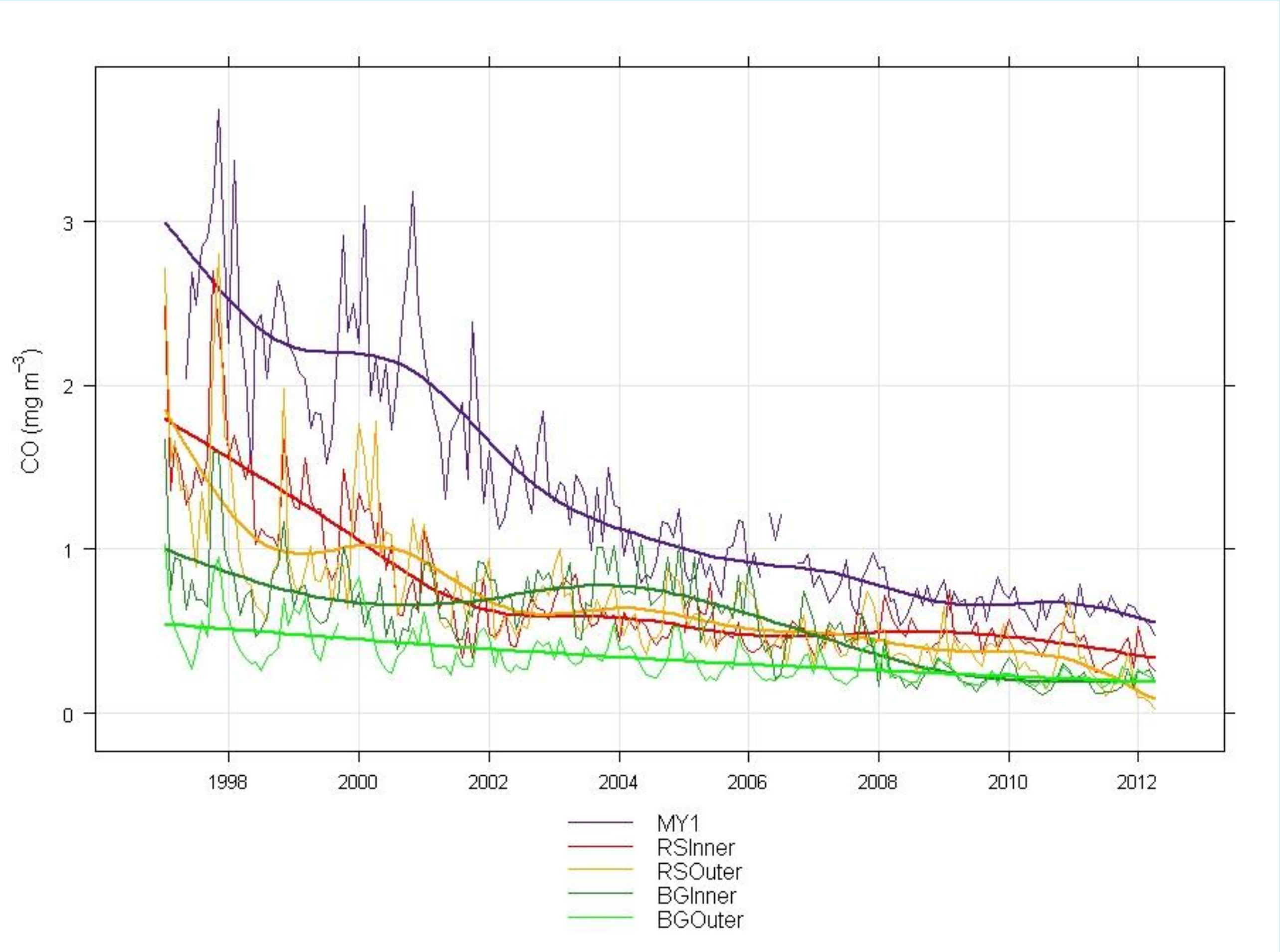
Widespread breaches of the AQS Objective despite the miserable summer
Decreases in London decrement as observed by AQEG (2009)



CO

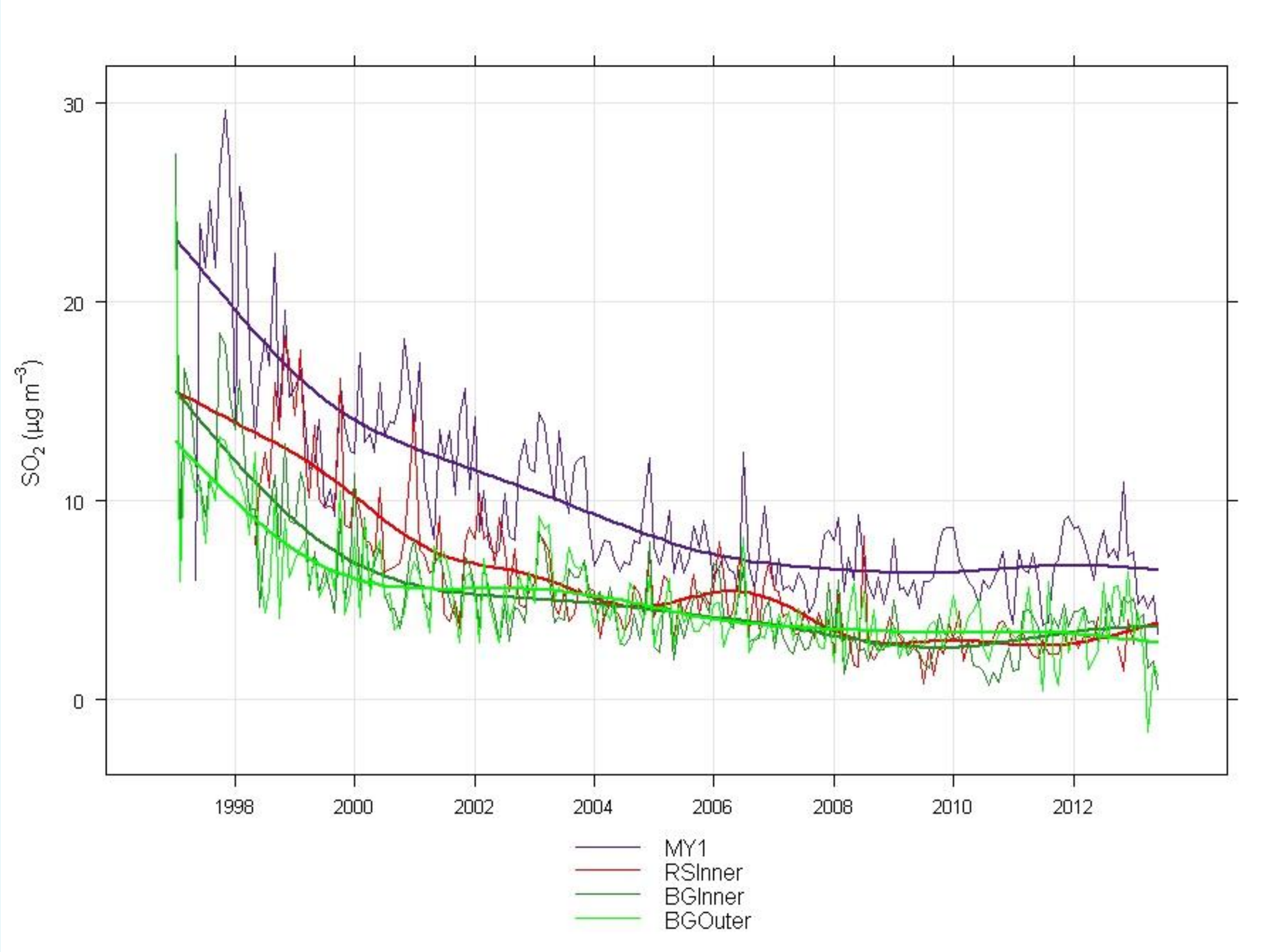
Used to be a pollutant associated with petrol vehicles. Now very well controlled by vehicle exhaust after treatment

WHO Guideline / EU LV not exceed in London since late 1990s



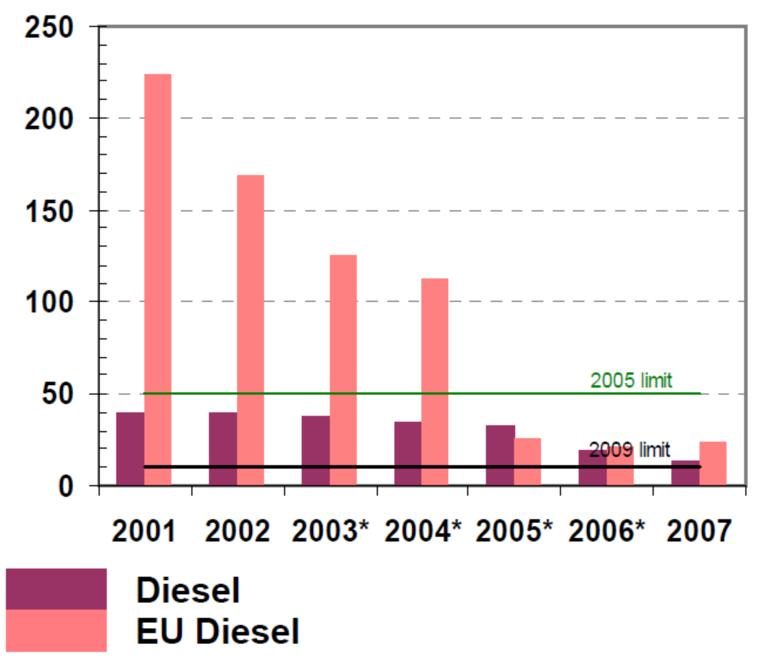
SO2

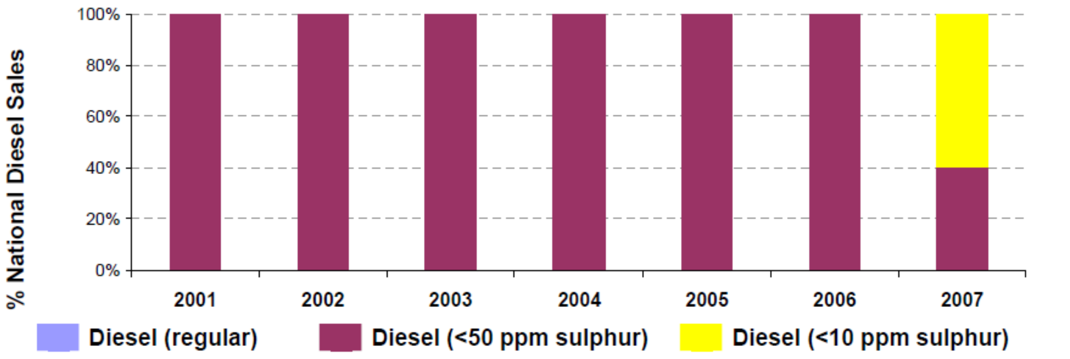
Improvements in industrial emissions and S content of fuel
(only one RS Inner site here)
Some ‘moderate’ SO2 in 2006 heatwave & just before Olympics.



SO2

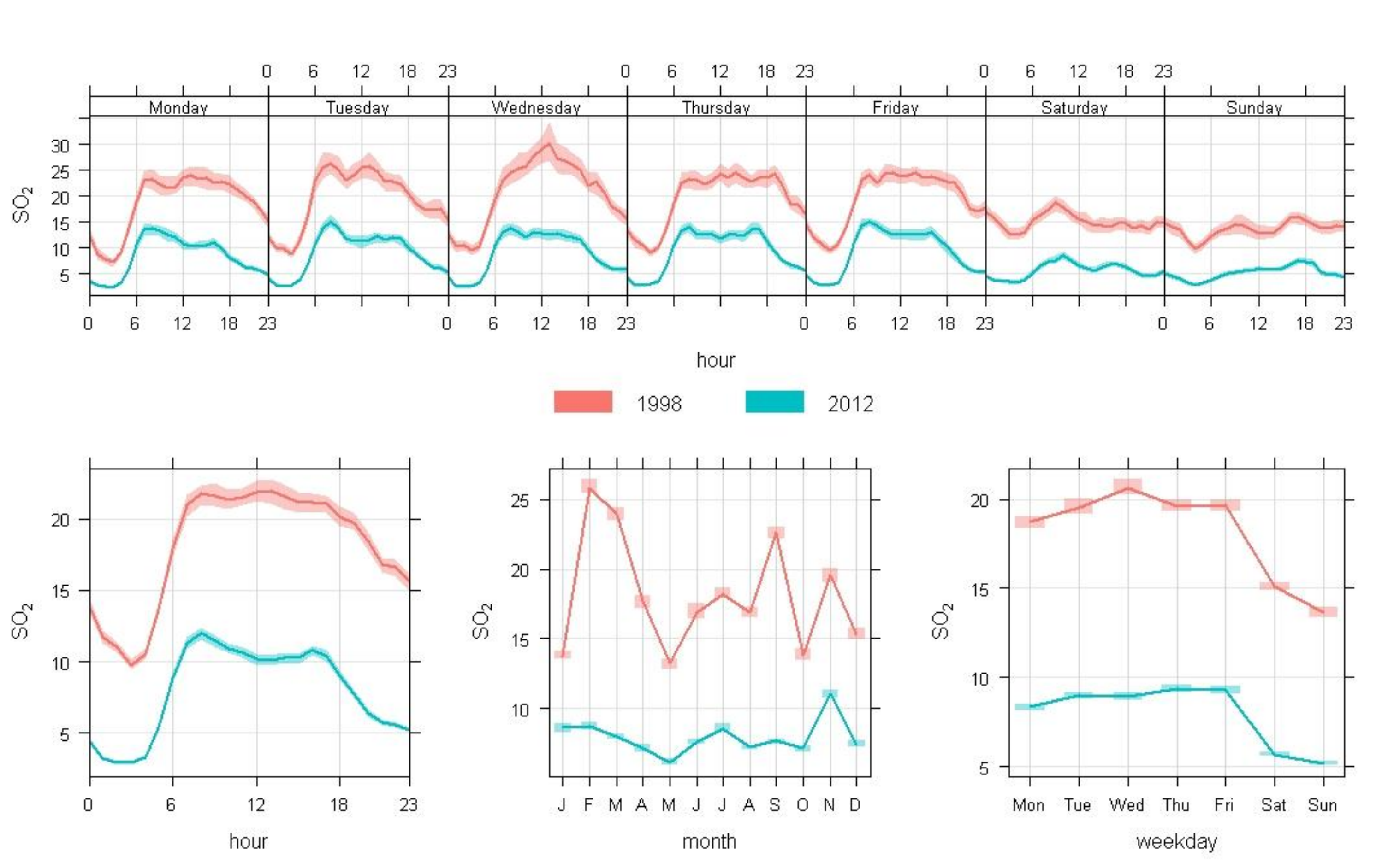
Changes in road fuel S – Brannigan et al., 2009
(Last report related to 2007 and no further EU reports since)





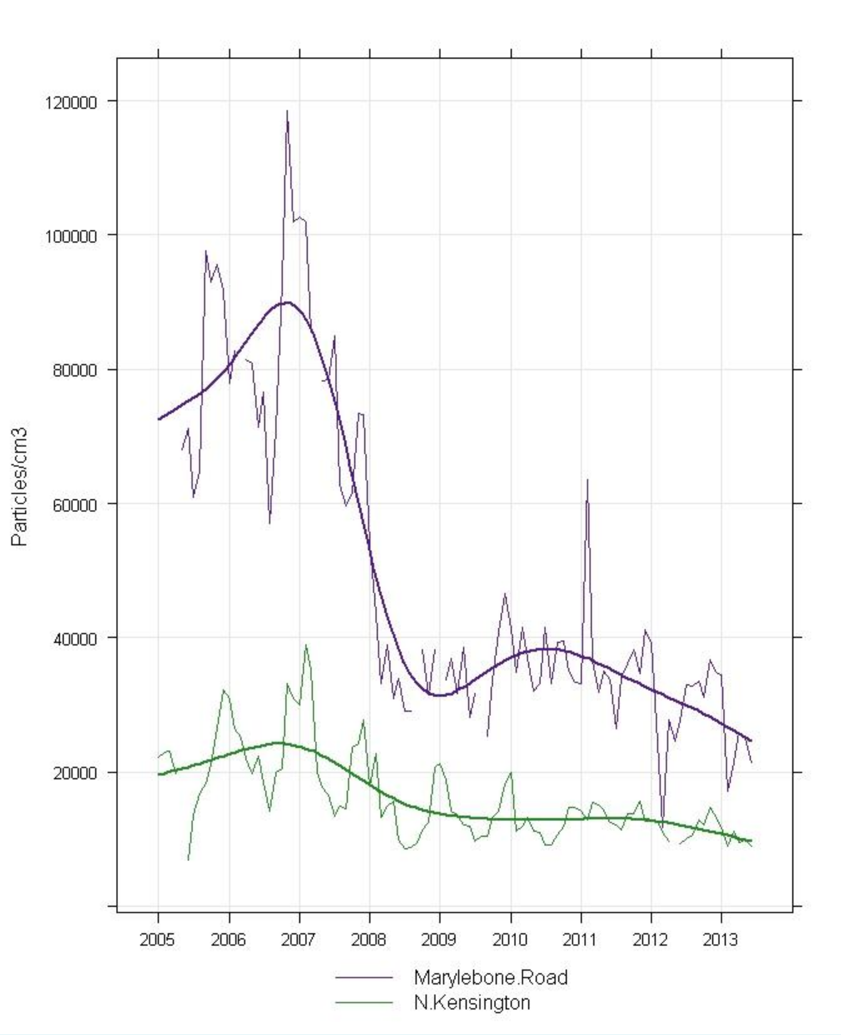
SO2

Changes in diurnal concentrations at Marylebone Road



Particle number concentration

Change reported in Jones et al., 2012



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A large reduction in airborne particle number concentrations at the time of the introduction of “sulphur free” diesel and the London Low Emission Zone

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[b] Gary Fuller and Benjamin Barratt, Environmental Research Group, Kings College, 150 Stamford Street, London SE1 9NH, United Kingdom

Particle number concentration

Why is this important?
Atkinson et al 2010

ORIGINAL ARTICLE

Urban Ambient Particle Metrics and Health

A Time-series Analysis

Richard W. Atkinson,[a] Gary W. Fuller,[b] H. Ross Anderson,[a] Roy M. Harrison,[c] and Ben Armstrong[d]

Background: Epidemiologic evidence suggests that exposure to ambient particulate matter is associated with adverse health effects. Little is known, however, about which components of the particulate mixture (size, number, source, toxicity) are most relevant to health. We investigated associations of a range of particle metrics with daily deaths and hospital admissions in London.

particular because exposures were based upon data from a single centrally located monitoring site. There is a need for replication with more comprehensive exposure data, both in London and elsewhere.

(*Epidemiology* 2010;21: 501–511)

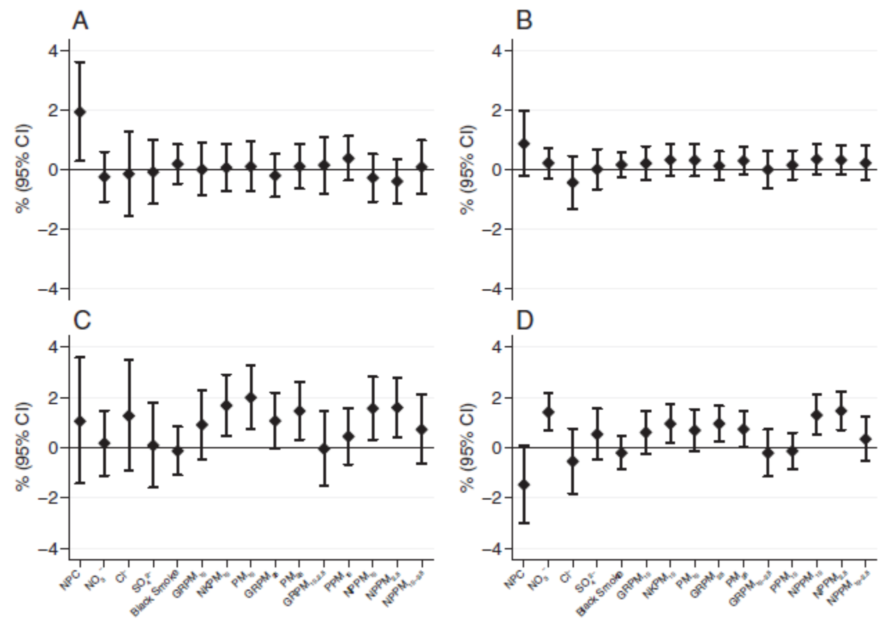
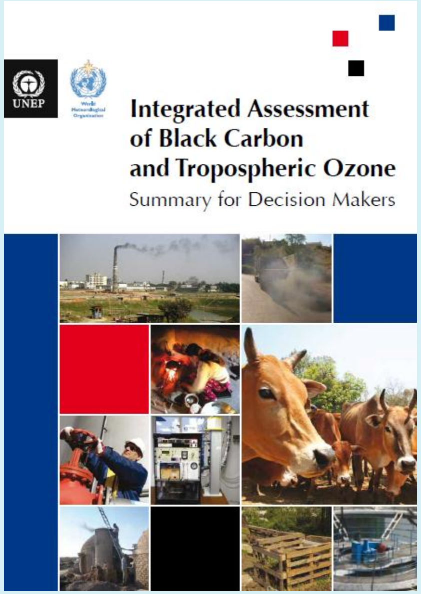


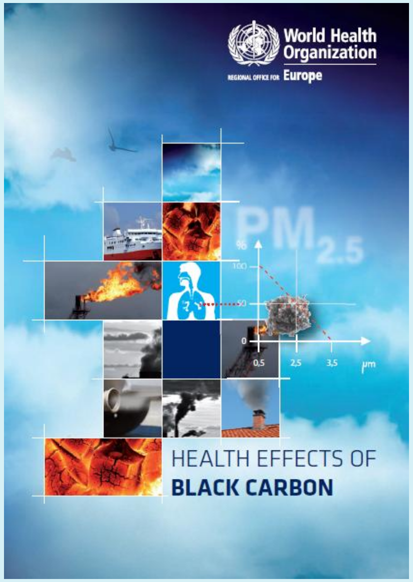
FIGURE 3. Associations of particle metric lag 1 day with cardiovascular and respiratory mortality and admissions. A, Cardiovascular mortality; B, cardiovascular admissions; C, Respiratory mortality; and D, respiratory admissions. All measurements are from North Kensington, except black smoke, which was measured at a number of locations across London.

Black carbon

Black carbon is a short-term climate forcer as highlighted by recent UNEP assessment (UNEP, 2011; Shindell et al 2012; Shine et al 2007).

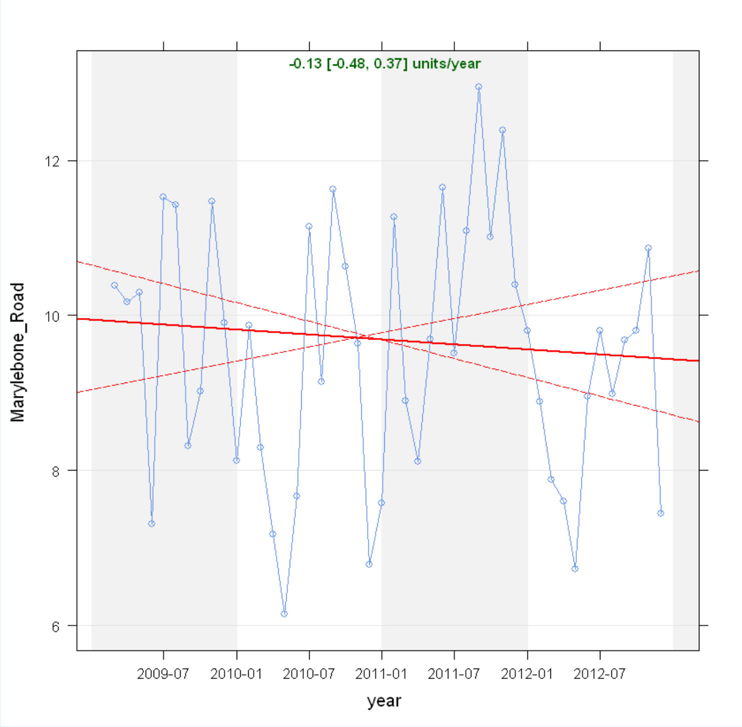
Black carbon has been shown to be a better predictor of short-term air pollution health effects than PM mass metrics (Janssen et al 2011; 2012 - for WHO)

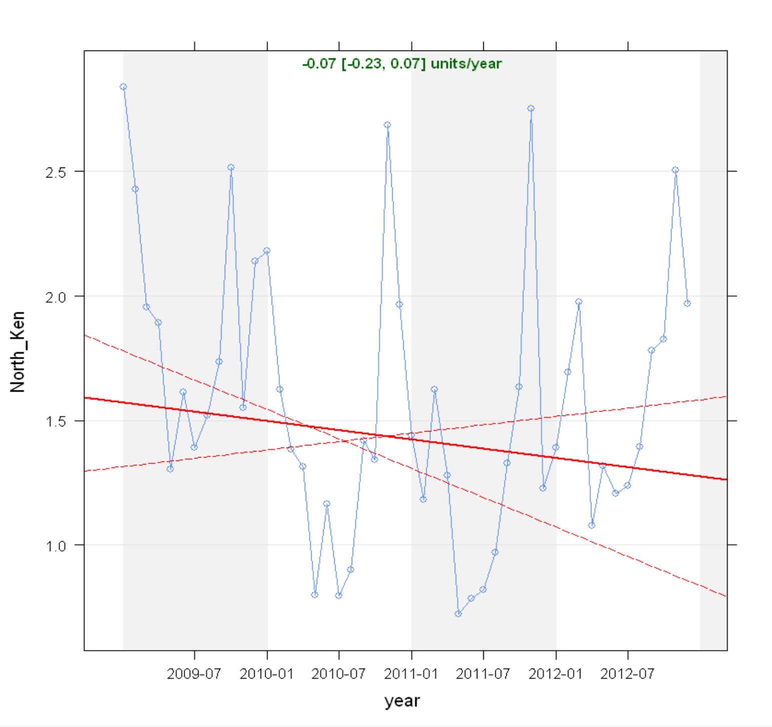




Black carbon

Aethalometer measurements from the Defra BC network show no trend for London (Butterfield et al 2013, NPL)





Black carbon

Longer term trends can be discerned from converting black smoke to black carbon
by Heal & Quincey 2012 . Trends using TheilSen see
www.openair-project.org
Thanks to Pam Davy, King's.

Available online at www.sciencedirect.com
ScienceDirect
Atmospheric Environment 41 (2007) 7964–7968
ATMOSPHERIC ENVIRONMENT
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Short communication

A relationship between Black Smoke Index and Black Carbon concentration

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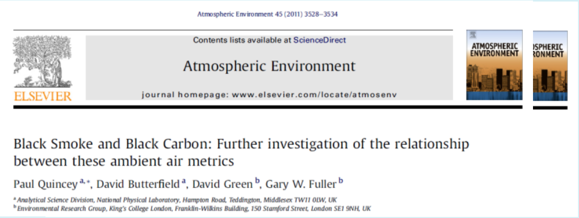
Received 20 July 2007; received in revised form 30 August 2007; accepted 10 September 2007



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Black Smoke and Black Carbon: Further investigation of the relationship between these ambient air metrics

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The relationship between black carbon concentration and black smoke: A more general approach

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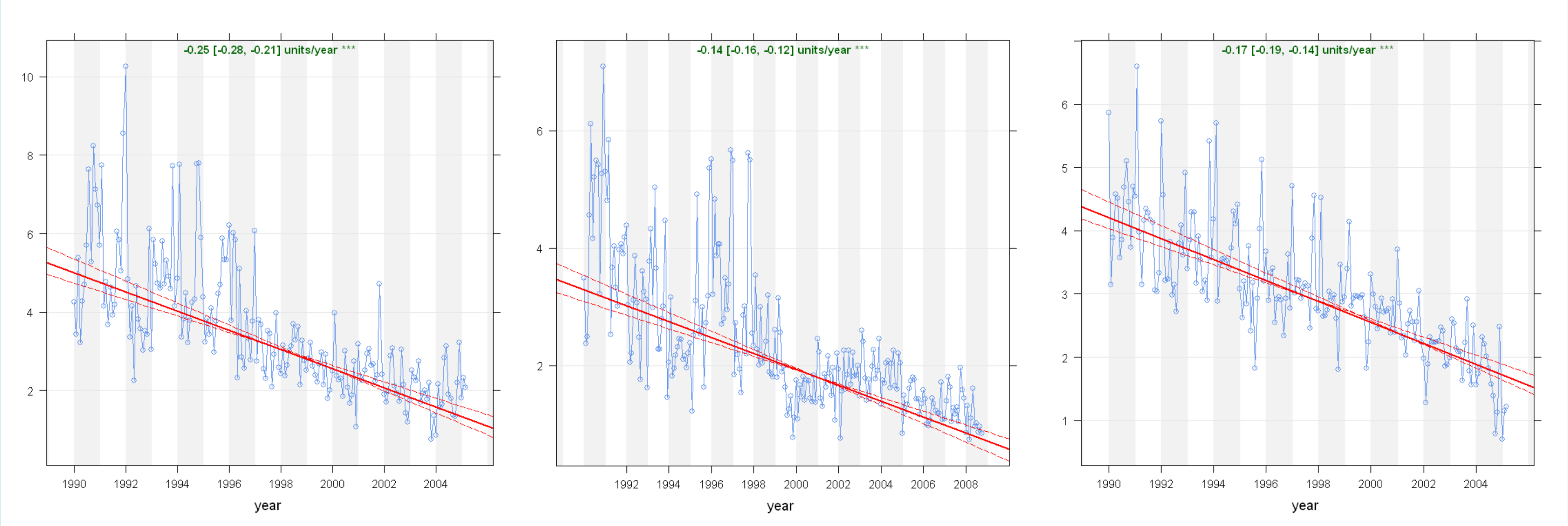
[b] Analytical Science Division, National Physical Laboratory, Hampton Road, Teddington, Middlesex TW11 0LW, UK

Inner London background

Outer London



Conclusions

Changes in air pollution in London over the last ~ 10 years show the successful outcomes of some measures to abate road traffic emissions (mainly from petrol vehicles), reduction of S in road fuel, industrial emissions abatement and the decrease in some long-range transported pollutant emissions.

Decreases in NOX, SO2 and CO early in C21 but have slowed since.

Very large breaches of the AQS/ LV for NO2 in London. Background NO2 has decreased and there is some indication of slight decrease in road NO2 since 2010 but the picture is complex.

AQS/LV compliance for PM10 is marginal, depending on the sites considered and assessment methods.

Conclusions

PM10 decreases in the last ten years due to regional background. Some downward trends in BC to 2004 ~ 0.1 – 0.2 ug m^{-3} y^{-1} but changes in PM from London are not clear. Trends in PM10 and especially PM2.5 are confounded by the number of monitoring sites and changes in methodologies. The large decreases in SO2 concentrations have not resulted in equally dramatic decreases in sulphate PM.

Reduction in S in road fuel has reduced SO2 from traffic and ultra-low S diesel brought about a dramatic decrease in particle number concentrations, the fastest / largest pollutant decrease in the last decade. There is some evidence of associations between daily particle number and cardio- vascular deaths and hospital admissions.

O3 should not be ignored as concentrations in London rise towards regional background and the regional background itself is slowly increasing (AQEG, 2009).

Thanks

This presentation has involved the crunching of 10s of millions of air pollution measurements – mainly by Louise Mittal

Thank you all the London boroughs, GLA, Defra and TfL who support the London Air Quality Network enabling this unique London-wide perspective.