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Air pollution impact of Buncefield Oil Depot Fire

Measurements from the London, Sussex and Herts. & Beds air quality monitoring networks

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King's College London

June 2006



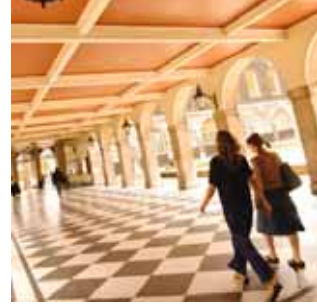
Contents

A reminder of what happened

Disseminating information

Air quality day by day – looking for needles in a haystack!

Quantification of the PM_{10} impacts of Buncefield



Sunday 11th December 2005

Photos from Royal Chiltern Air Support Unit





Sunday 11th December 2005

Ian Troughton KCL





Sunday 11th December 2005

Press photos





Disseminating Information

Sunday AM - increased data collection from all TEOM sites to hourly.

Set up an incident management team distinct from network duty team

Daily pollution incident notifications.

Daily updated notifications on all network web pages.

Press release on Monday

Built hourly data feed to HPA (CHaPD) on Tuesday.

DEFRA and HPA (CHaPD) briefings from Tuesday

Numerous public enquiries

Press enquires - print, radio and TV

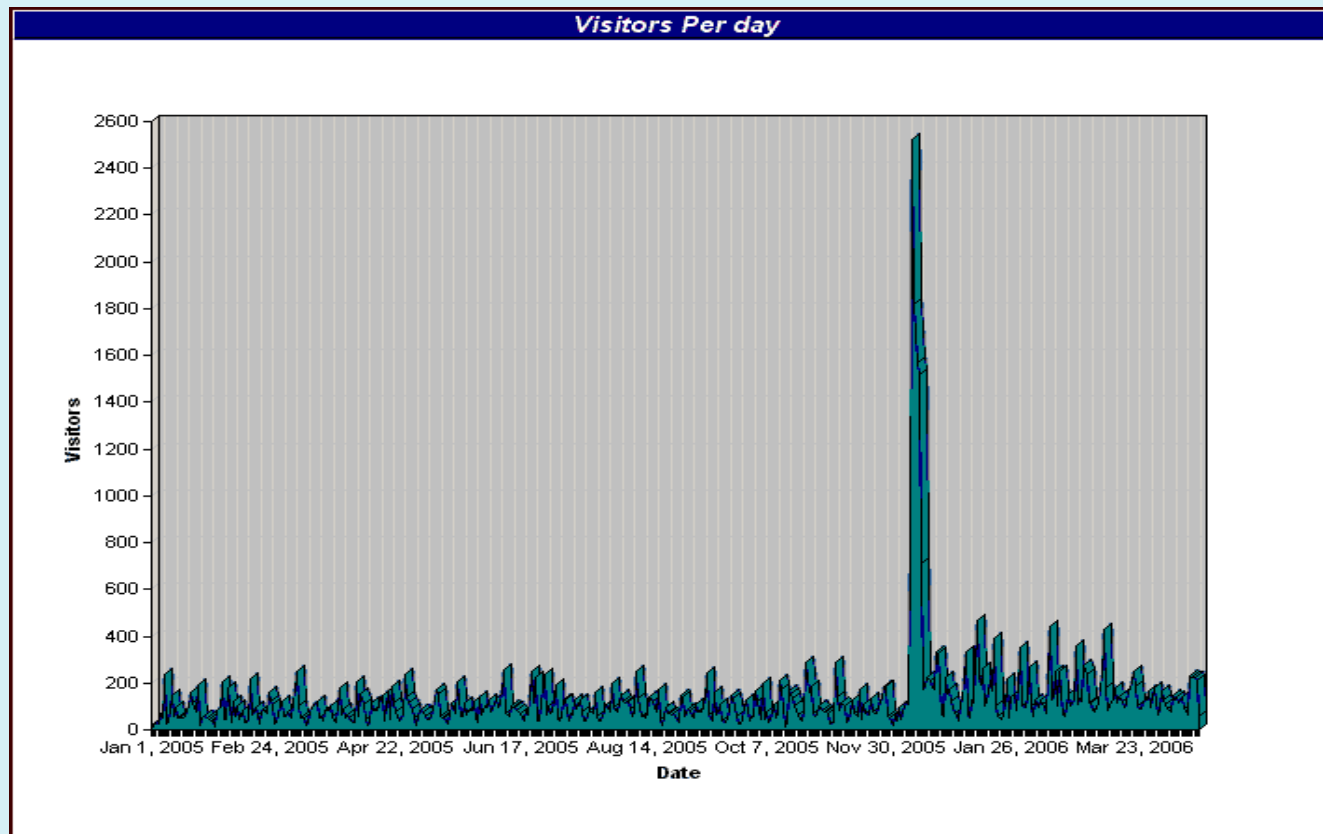
Hourly and daily updated regional network web sites

Visitors to LondonAir and KentAir increased by 3X

Visitors to HertsBedsAir increased by 20X



HertsBedsAir Visitors





Web bulletins – final air quality summary



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Air pollution summary for the period of the Buncefield Oil Storage Depot fire from regional air quality networks in London and SE England

Issued by the Environmental Research Group at King's College London 21st December 2005.

There was substantial public concern regarding the air pollution impact of the fire at the Buncefield Oil Storage Depot in Hertfordshire. The level of public concern is illustrated by the visitors to the regional air quality monitoring network web sites discussed below.

The plume from the fire did not result in widespread high pollution concentrations.

The fire began with an explosion around 0603h on Sunday 11th December 2005. On the evening of Sunday 11th and early in the morning of Monday 12th, the smoke from the fire was detected at monitoring sites in parts of east Surrey and Sussex causing PM10 particulate concentrations to reach 'moderate' levels in Horsham and Lewes. The plume was also detected at monitoring sites in north London and St Albans but concentrations here remained 'low'.

On the evening of Tuesday 13th, PM10 particulate from the fire was detected at the Barnet 2 background sites and on the morning of Wednesday 14th, PM10 particulate from the fire was detected at the Watford 1 site. In both cases concentrations remained 'low'.

Throughout the period of the fire 'moderate' PM10 particulate was measured at several roadside sites in London. This was due to road transport sources and was not directly related to the smoke from the oil depot fire. 'Moderate' PM10 concentrations at the Chichester 1 site were due to nearby road resurfacing.

Air pollution in London and the Home Counties is measured by four regional air quality monitoring networks managed by King's College London and comprising over 130 local authority monitoring sites.

Visitors to the HertBedsAir web site increased by a factor of 20 in the week following the fire and visitors to the LondonAir and KentAir web sites increased by a factor of 3.

In response to the incident data collection frequencies were increased for PM10 particulate monitoring sites to maximise the real-time information available to the public and to health professionals. The additional cost for this data collection was borne by KCL.

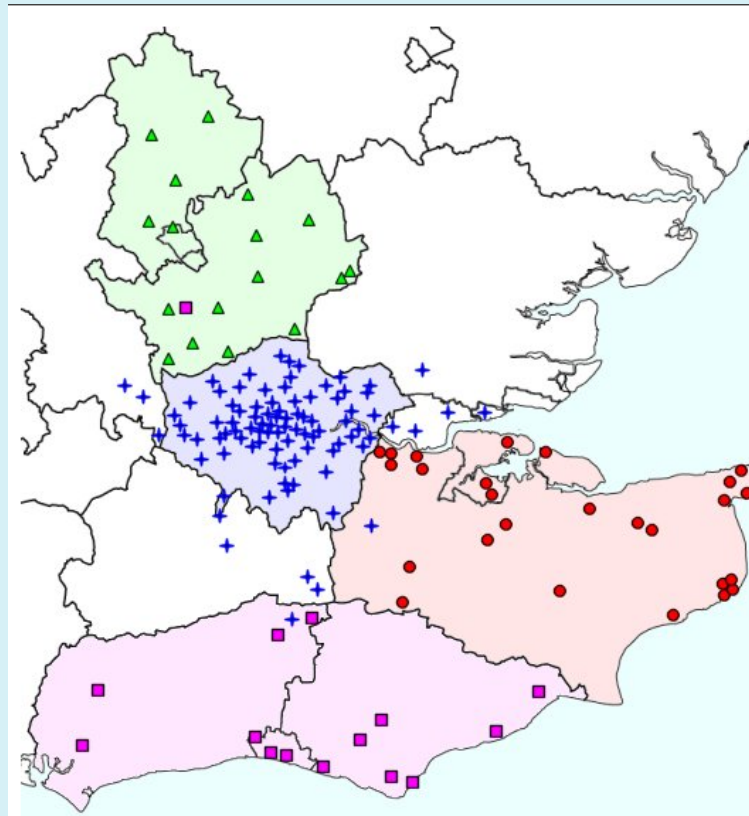
Measurements from each network can be found on the following web sites:

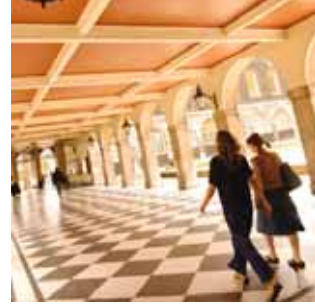
www.londonair.org.uk
www.hertsbedsair.org.uk
www.kentair.org.uk
www.sussex-air.net





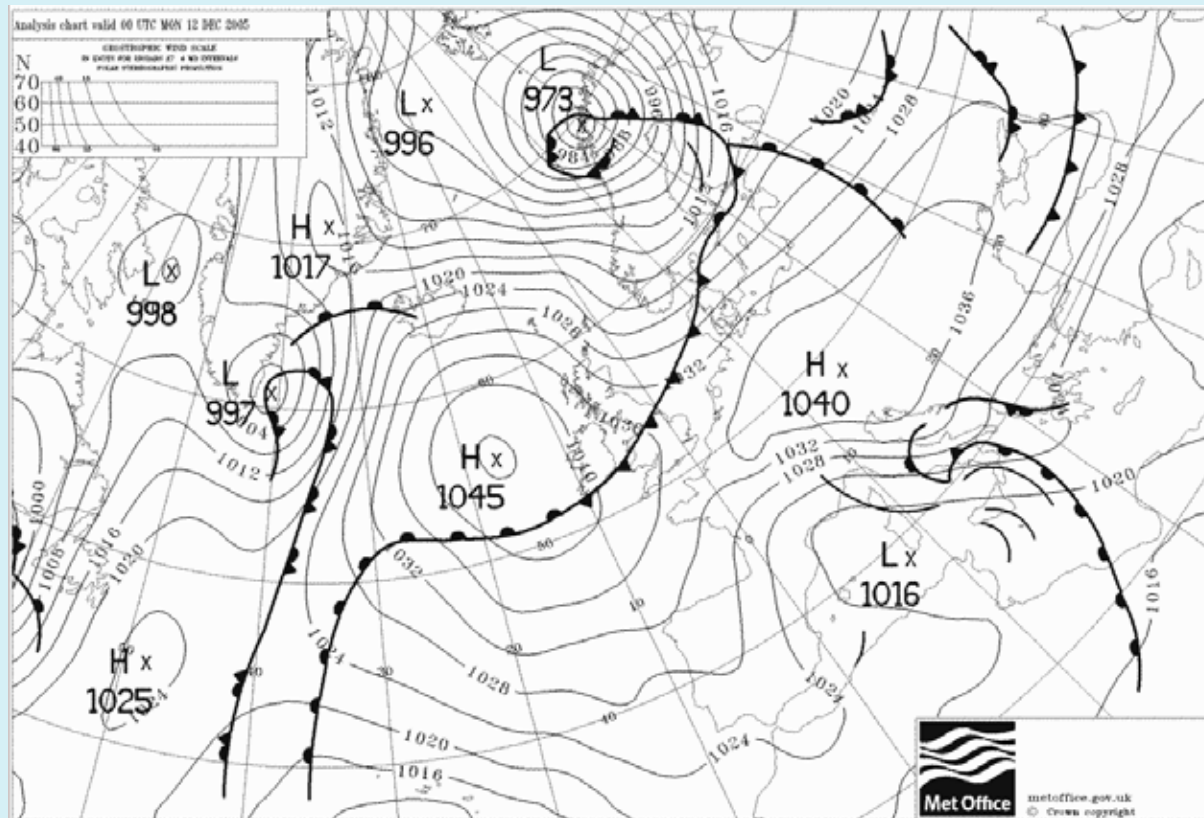
Air pollution measurements





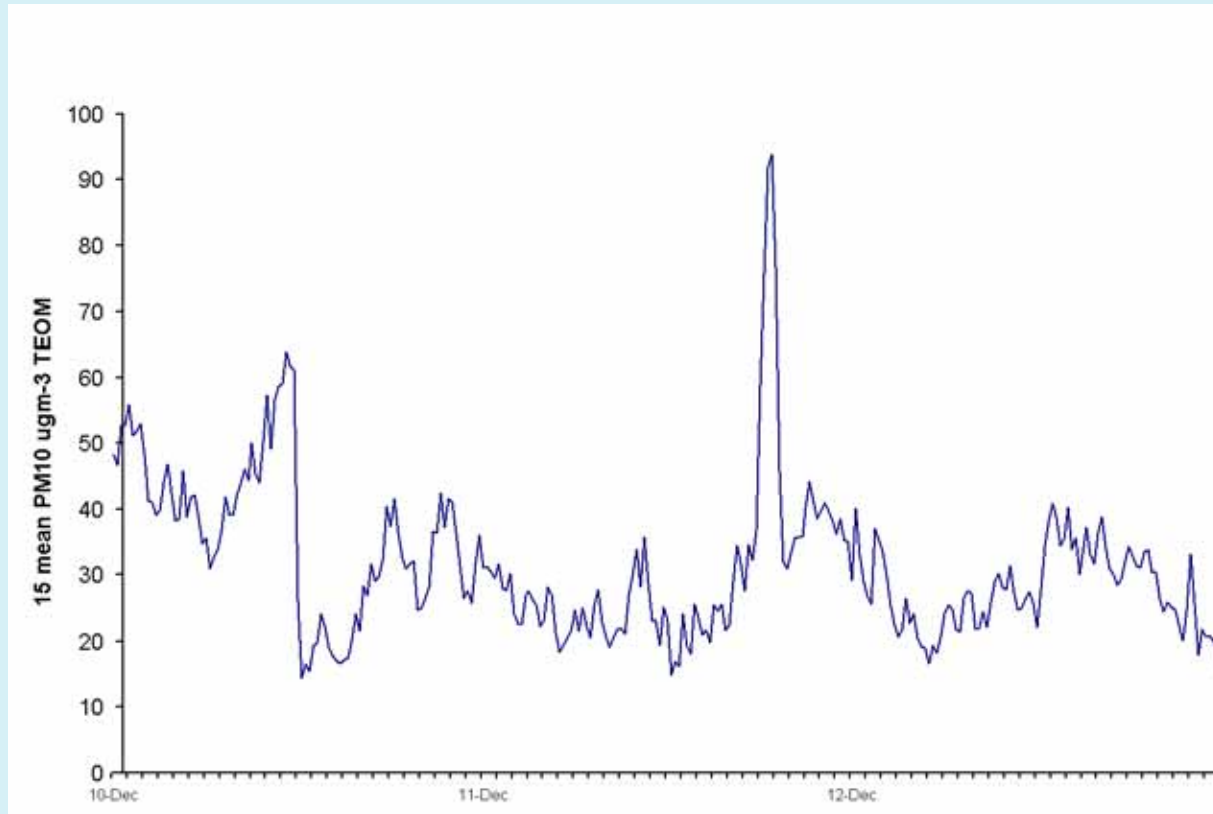
0h 12th December 2005

Thanks to TopKarten and with apologies to the Met. Office



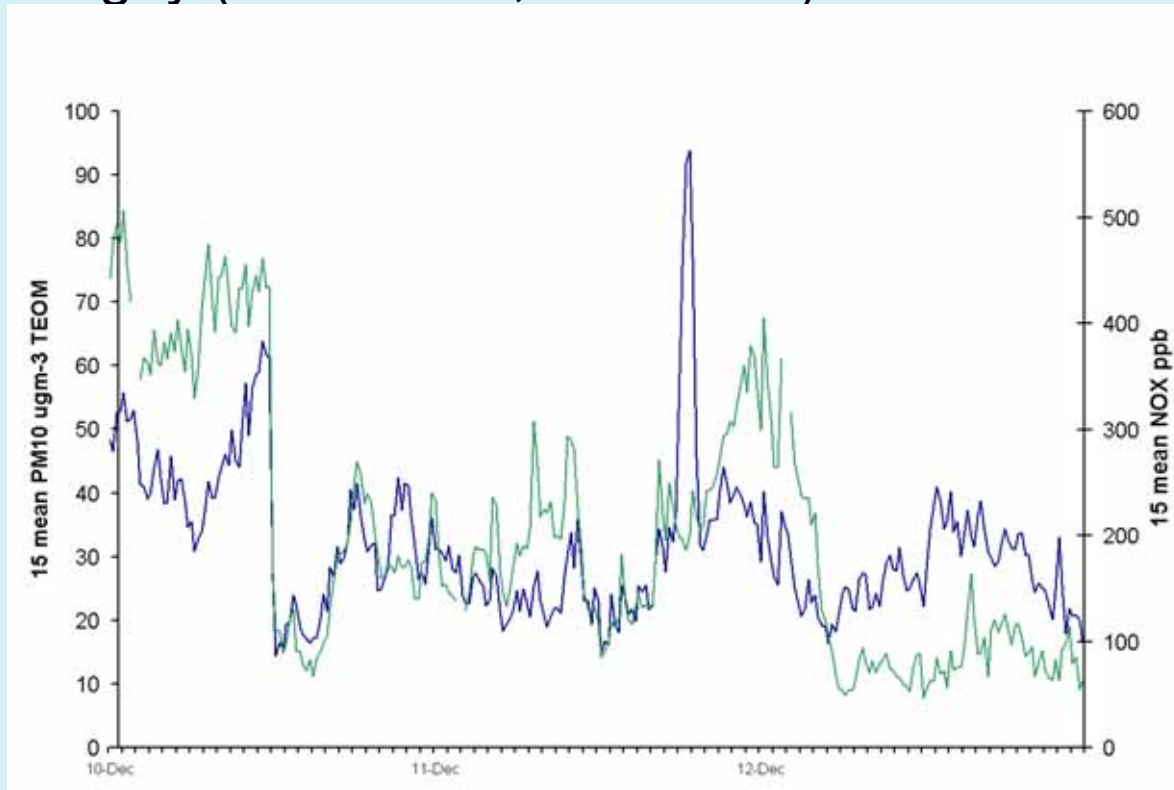


Sunday and Monday Looking for needles in a haystack Haringey (Tottenham, N London)



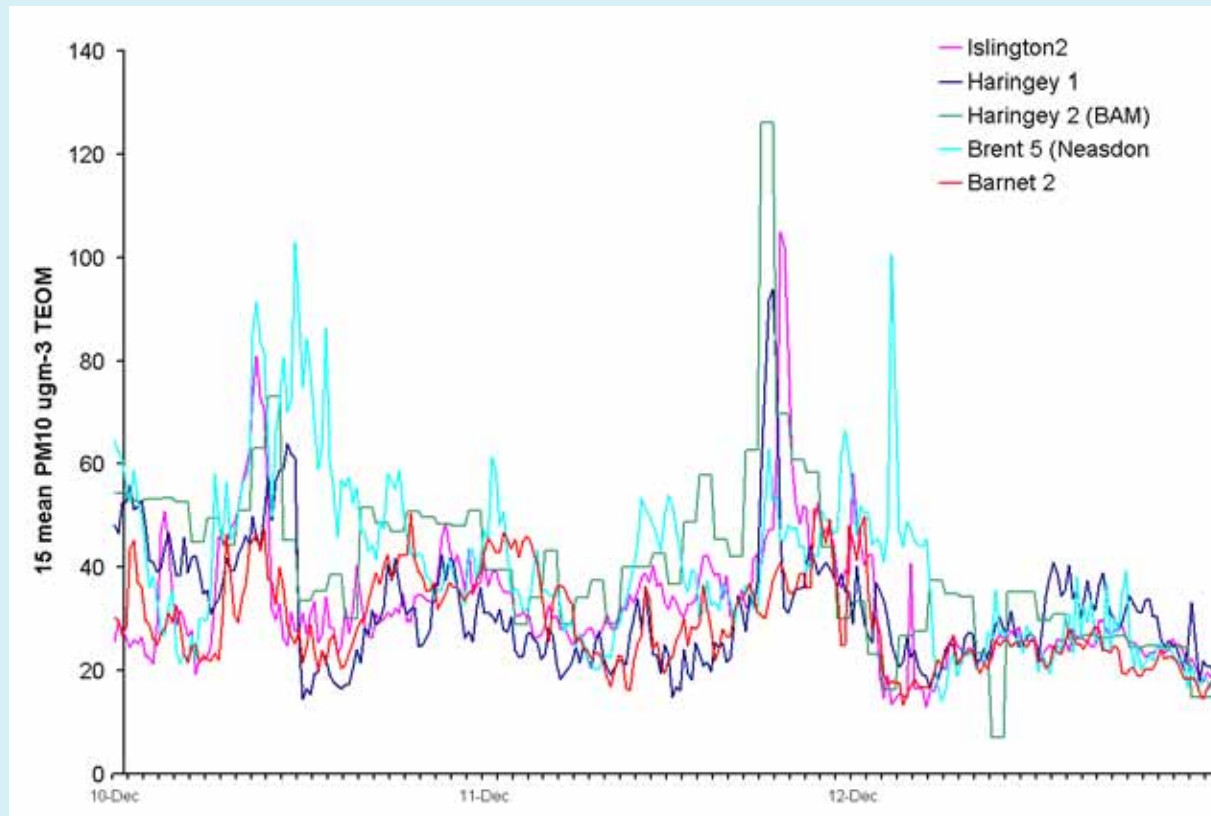


Sunday and Monday Looking for needles in a haystack Haringey (Tottenham, N London)





Sunday and Monday North London





'HC ratio peak at Marylebone Road

AEAT 2006

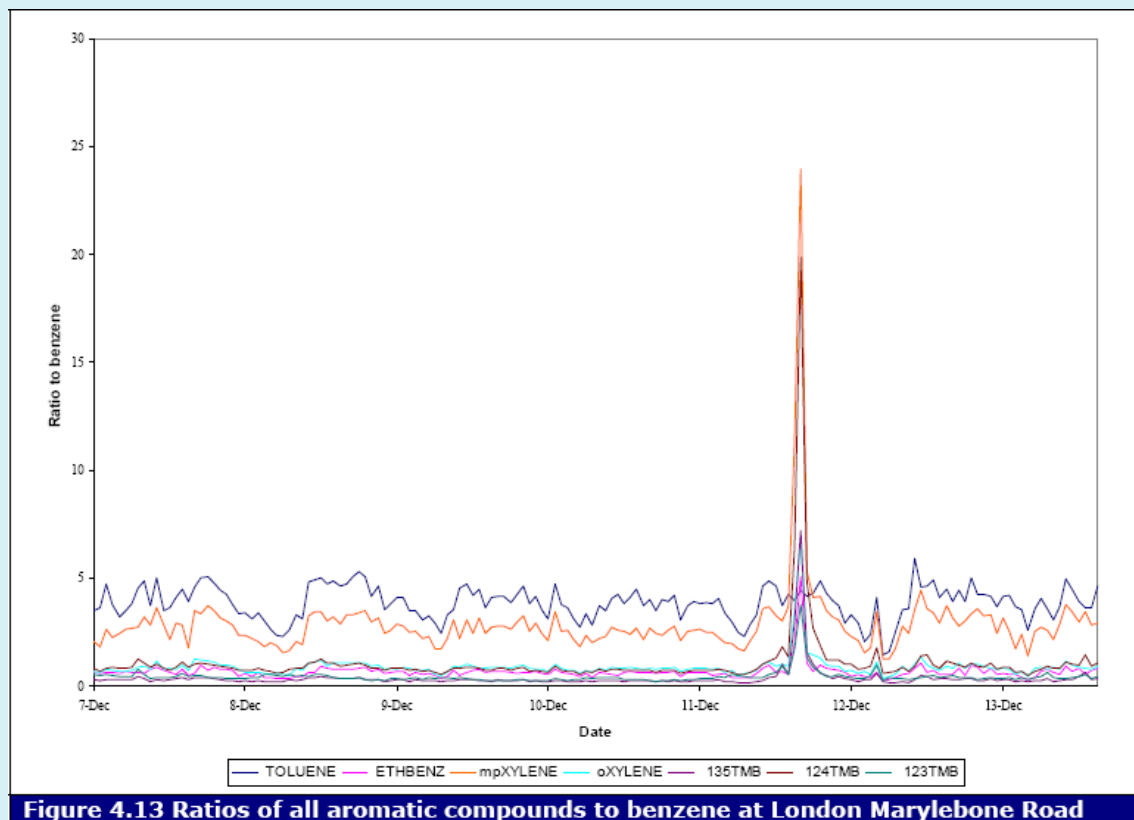
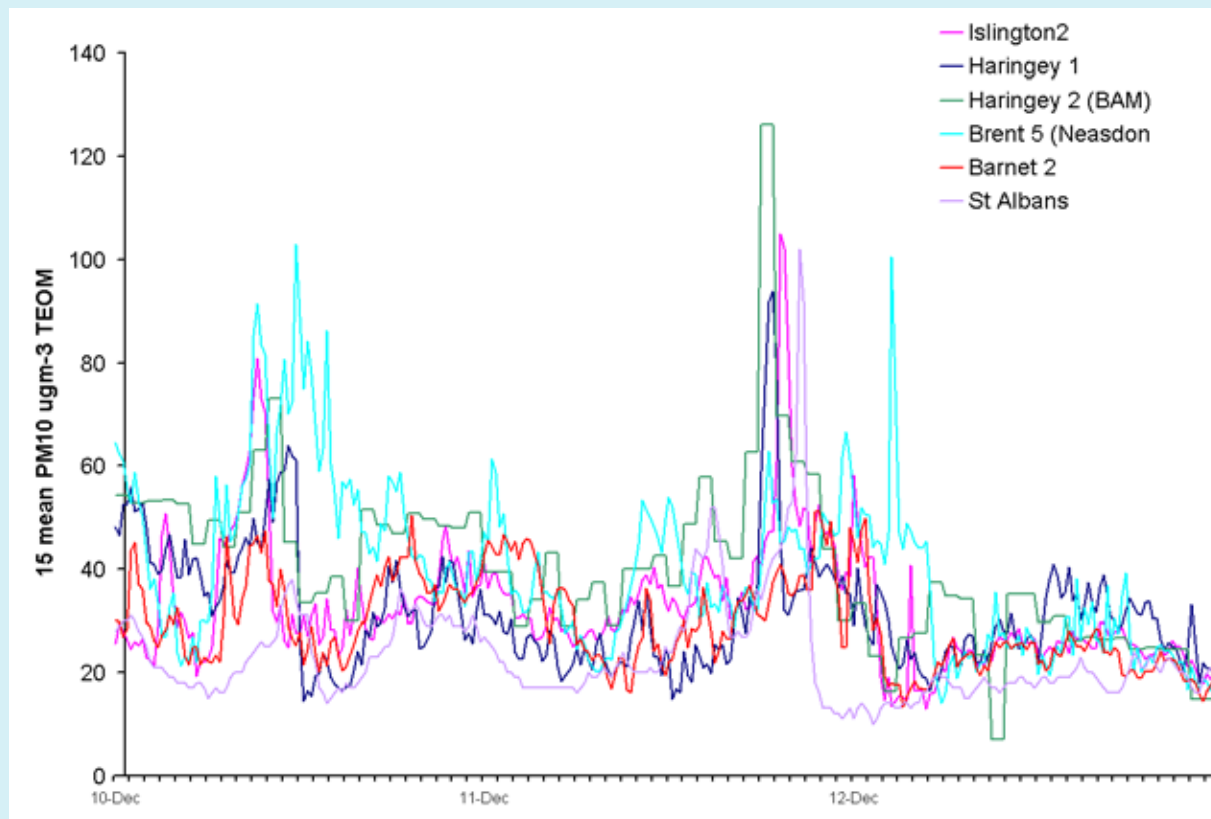


Figure 4.13 Ratios of all aromatic compounds to benzene at London Marylebone Road

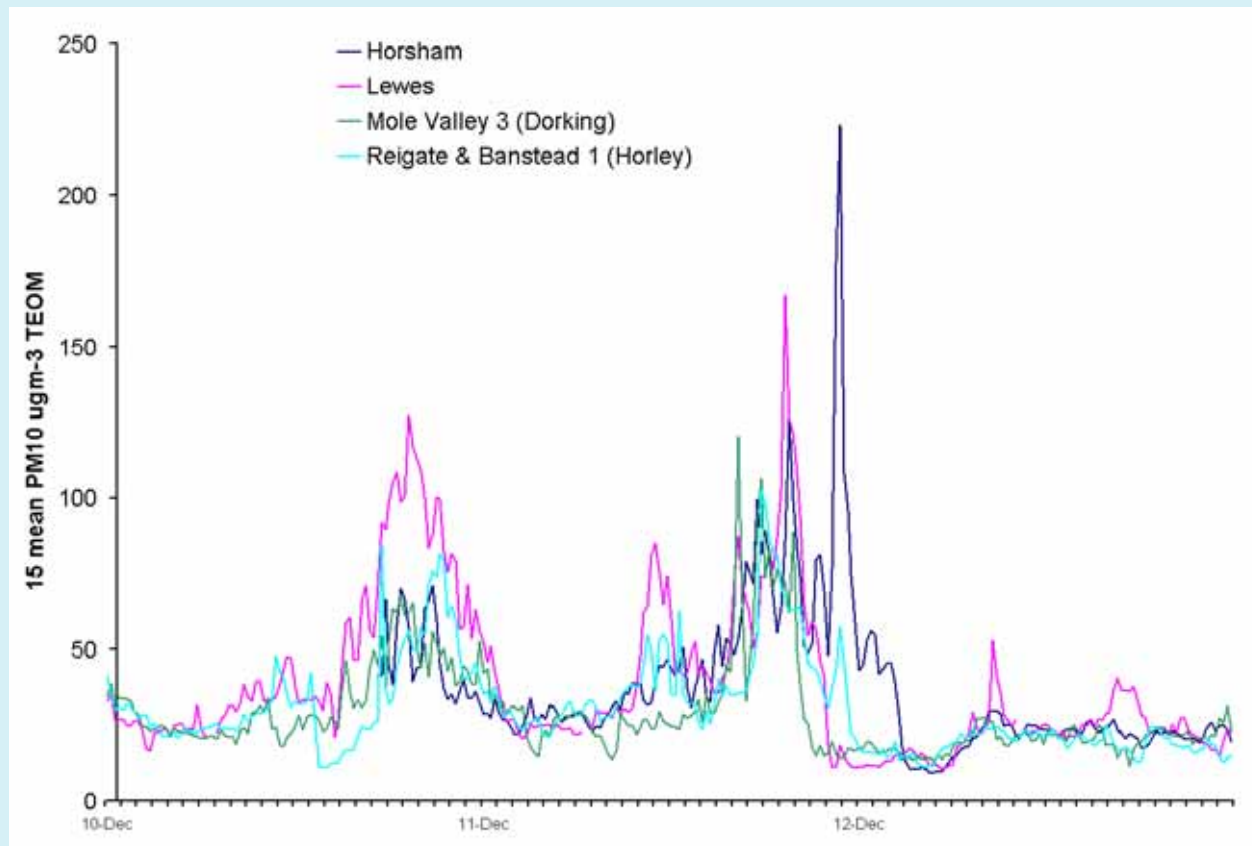


Sunday and Monday North London and St. Albans





Sunday and Monday Sussex and East Surrey





Tuesday and Wednesday

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News release

Further tests on smoke plume

13 December 2005

Scientists from the Met Office are hoping to fly into the smoke plume again today to get a clearer idea of what it contains.

A flight, by the Met Office/NERC research aircraft on Monday was only able to gather information from the fringes of the plume. However, initial findings are that the cloud is not toxic and mainly consists of carbon particles.

The Met Office has expertise in modelling releases into the atmosphere and is working with other agencies and groups to assess the changing situation.

The Met Office/NERC aircraft is fitted with hi-tech equipment - including an aerosol mass spectrometer which can analyse the chemistry of particles in the smoke.

As a result of a change in wind direction today the smoke is expected to move towards southern and south-east England. Light patchy rain is also forecast but it is not expected to cause any large scale wash-out of the sooty particles at ground level.

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FOOTPRINT OF PLUME
1200 on Tue 13 Dec 2005

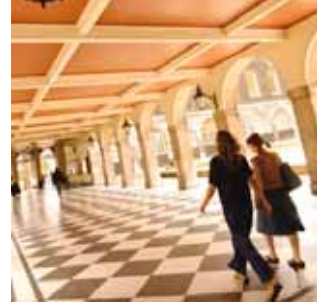
KEY TO EXTENT
■ MOST PROBABLE
■ TOTAL

FOOTPRINT OF PLUME
0600 on Wed 14 Dec 2005

KEY TO EXTENT
■ MOST PROBABLE
■ TOTAL

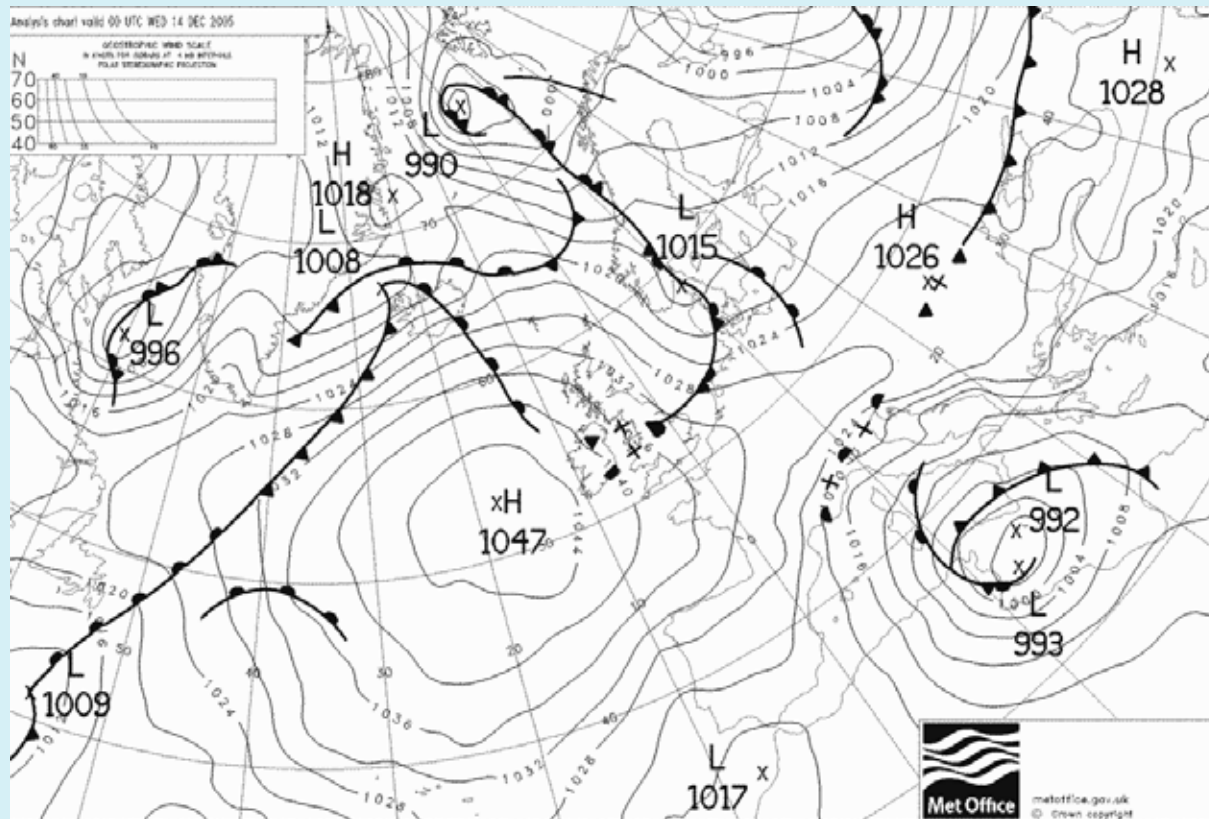
FOOTPRINT OF PLUME
1200 on Wed 14 Dec 2005

KEY TO EXTENT
■ MOST PROBABLE
■ TOTAL



0h 14th December 2005

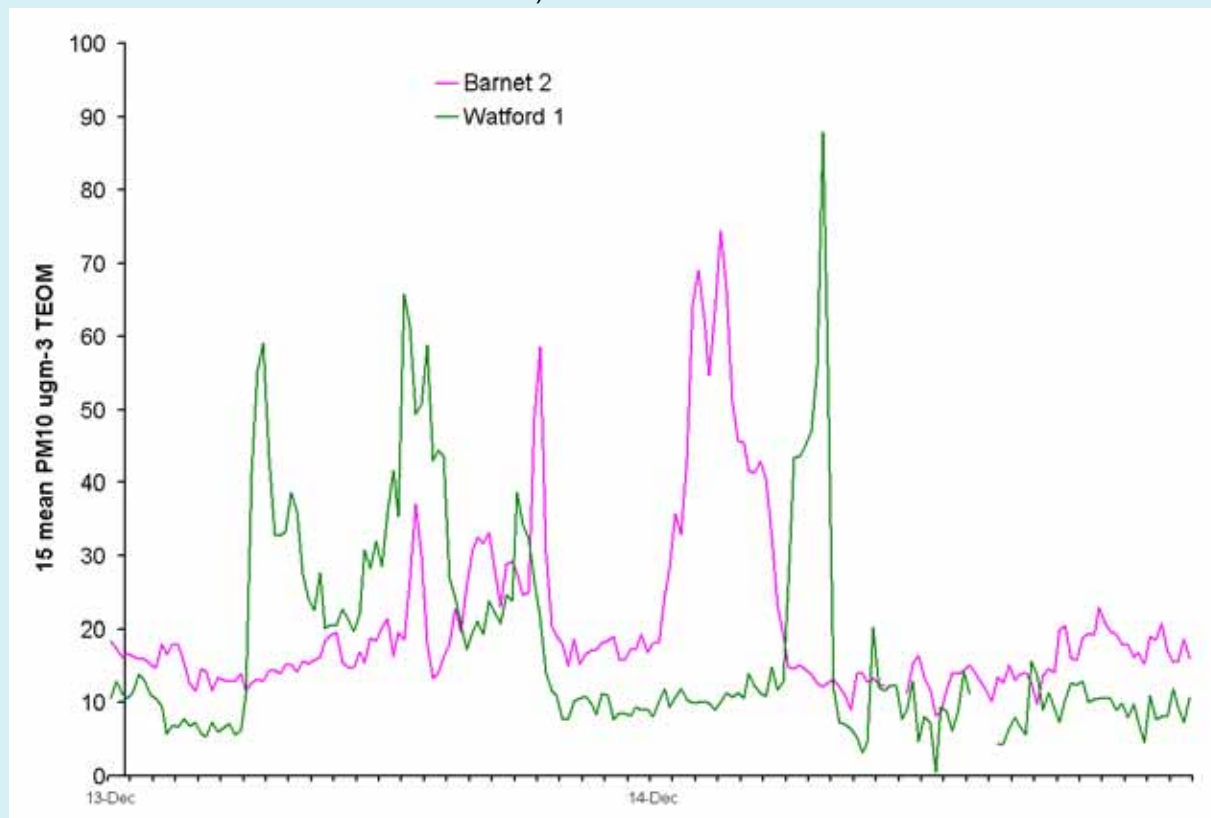
Thanks to TopKarten and with apologies to the Met. Office





Tuesday and Wednesday North London and Hertfordshire

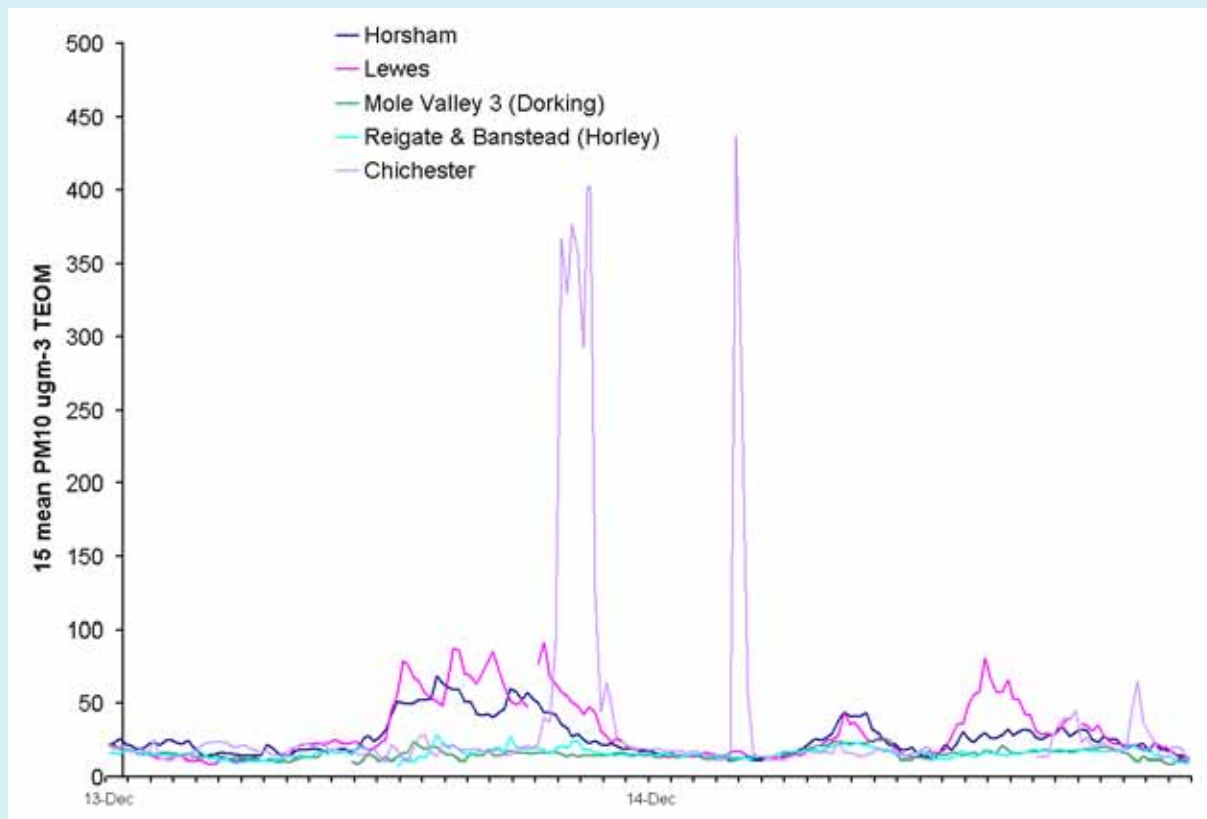
(Thanks to Watford BC staff for their observations)

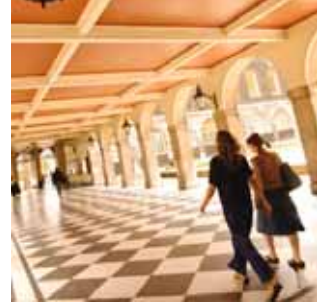




Tuesday and Wednesday Sussex again?

(Thanks to Simon Ballard and Kate Grovey CDC for their investigations)

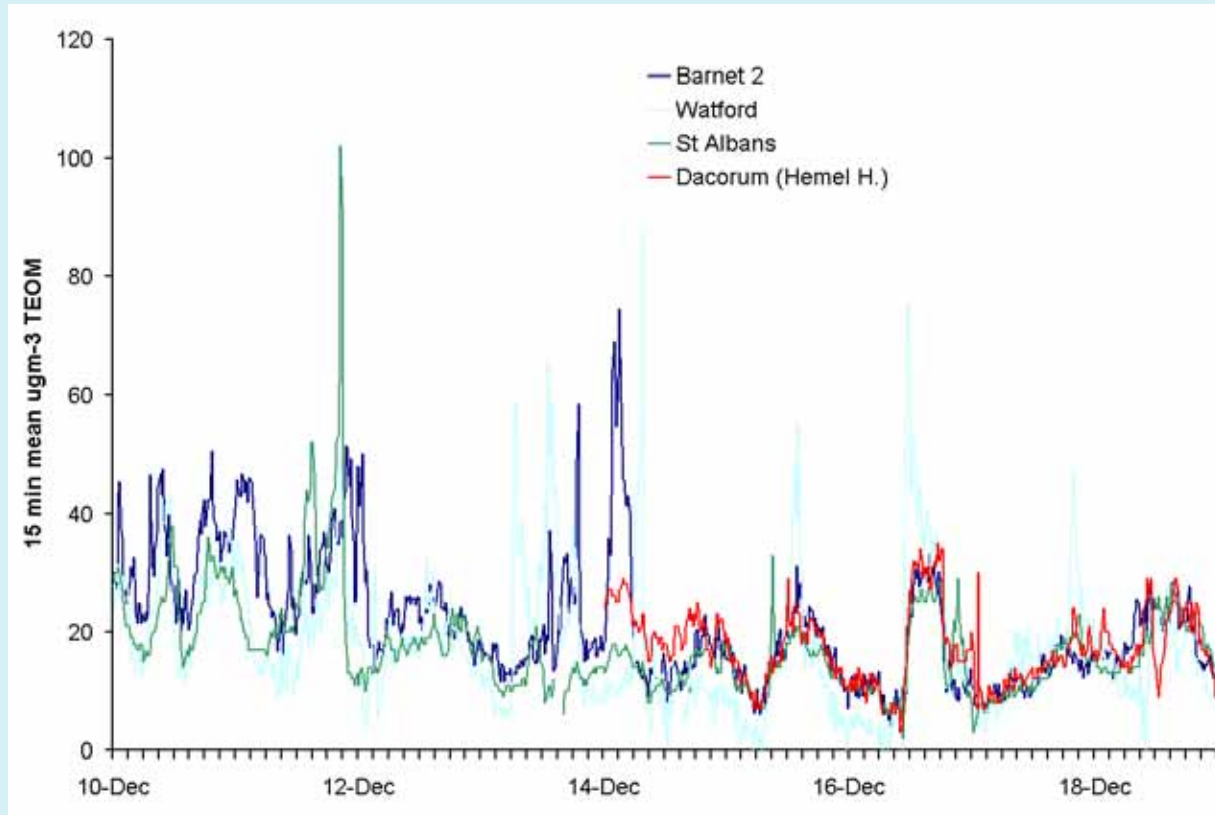




Wednesday

The Dacorum site is (re) born

Daniel Marsh of KCL and also thanks to Casella ETI who also provided engineers for free





Measurement Summary

Incident	Date	Time of max Conc	Area	Site	Max 15 mean Conc
					$\mu\text{g m}^{-3}$ (grav)
A	11-Dec	16:15	Surrey & Sussex	Mole Valley 3 - Dorking	156
A	11-Dec	17:45	Surrey & Sussex	R'gate & Bans 1 - Horley	133
A	11-Dec	19:15	Surrey & Sussex	Lewes 2	217
A	11-Dec	22:45	Surrey & Sussex	Horsham 2	290
B	11-Dec	20:30	Hertfordshire	St Albans - Fleetville	133
C	11-Dec	18 h - 19h	North London	Haringey 2 - Priory Pk*	102
C	11-Dec	18:45	North London	Haringey 1 - Tottenham	122
C	11-Dec	19:15	North London	Islington 2 - Holloway Rd	137
C	12-Dec	02:30	North London	Brent 5 - Neasden	130
D	14-Dec	03:00	North London	Barnet 2	98
D	14-Dec	07:30	Hertfordshire	Watford	114



Quantifying the PM_{10} impacts of Buncefield

What was the additional PM_{10} from Buncefield?

- Key question for epidemiology
- Did it cause 'moderate' concentrations or breaches of the EU Limit Value?

How?



Quantifying the PM_{10} impacts of Buncefield

Source apportionment divides PM_{10} into

- *primary (linked to NO_x)*
- *regional background (not linked to NO_x)*

Can be used predicatively to model PM_{10} at sites where NO_x is measured.

Modelled $PM_{10} = \text{Primary} + \text{Regional Background}$

Model does has no information about Buncefield.



Quantifying the PM_{10} impacts of Buncefield

Fuller, G., Carslaw, D.C., Lodge, H.W., 2002. An empirical approach for the prediction of daily mean PM_{10} concentrations. Atmospheric Environment 36, 1431-1441.

Fuller, G. and Tremper, A. 2004. Local Sources of PM_{10} measured at Thurrock 1. ERG, King's College London.

Fuller, G. W. and Green, D., 2004. The impact of local fugitive PM_{10} from building work and road work on the assessment of the European Union Limit Value. Atmospheric Environment 38, 4993-5002.

Fuller, G. W. and Green, D., 2006. Evidence for increasing primary PM_{10} in London. Atmospheric Environment (in press).



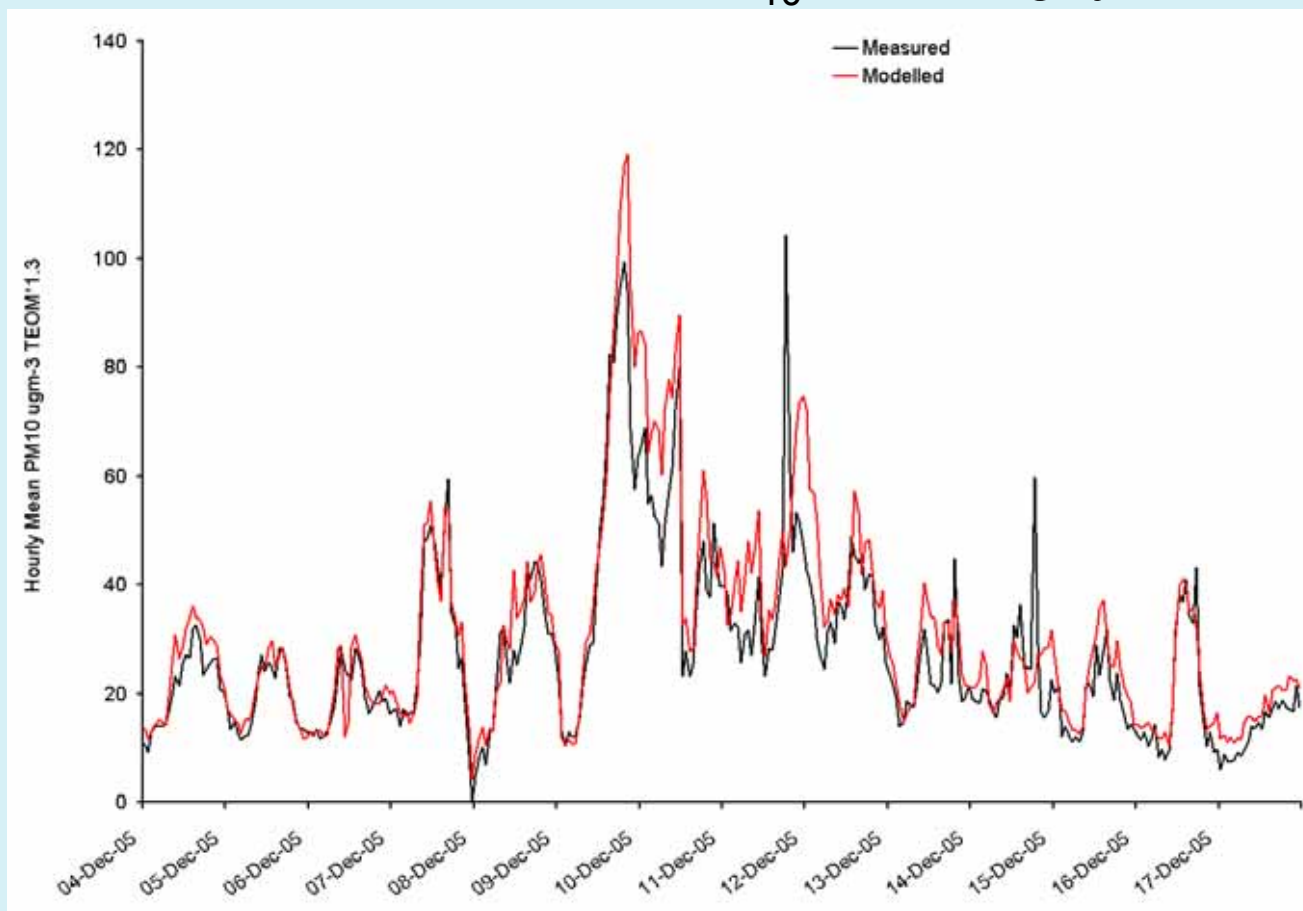
Quantifying the PM_{10} impacts of Buncefield

But.....

- *Model resolution needed to be increased from daily to hourly.*
- *Regional background had to be independent of Buncefield*
 - Calculated from sites in East London, Kent and N of B'field.



Measured and Modelled PM₁₀ at Haringey 1





Quantifying the PM_{10} impacts of Buncefield

'Unaccounted' PM_{10}

= Measured – Modelled

= $[PM_{10}] - (\text{primary } PM_{10} + \text{regional background})$

= $[PM_{10}] - ([NOX] A + \text{regional background})$

Need to calculate uncertainty to differentiate between model artefacts and possible effects of Buncefield.

Treated model calculation as a 'measurement equation' and used GUM approach.

— Coverage factor $k=2$ approx 2σ or 95% confidence limit



Other possible causes

Local sources?

Sunday - unlikely given spatial distribution

Watford and Barnet - fits with visual plume observations

TEOM measurement artefacts due to change in RH?

(eg Allen et al 1997, Jones et al 2001)

Not normally associated with +ve artefacts

Affected BAM too

Sunday episode coincides with HC anomaly at Marylebone Rd



Summary

Disseminating information to the public

Initial identification of possible Buncefield affects

Quantification of Buncefield effects

- Used PM₁₀ source apportionment
- Uncertainty assessment to identify model artefacts
- Impacts on 24 h mean range from
 - 1 +/- 1 $\mu\text{g m}^{-3}$ TEOM *1.3 to
 - 21 +/- 9 $\mu\text{g m}^{-3}$ TEOM *1.3 (24 h mean)
 - Contributed to 'moderate' air pollution at Horsham and Lewes
- Unlikely to be instrument artefact
- Questions remain about PM₁₀ artefacts measured in London on 14th Dec



Summary – Sites Affected

