




Establishing a biomass burning baseline for London – initial results

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Programme for 2010

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Why are we concerned about biomass PM in London?

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Background

PM from wood burning is getting greater recognition as an issue:

- 25% PM10 wintertime emissions in Oslo (Yttri et al. 2005).
- 34% PM10 emissions in Seattle (Maykut, 2003).
- ~ 90% of winter PM10 in Christchurch and linked to hospital admissions (McGowan, 2002).
- 10 – 30% of PM2.5 in Paris during wintertime study (Favez et al., 2009).
- Concern in alpine regions too.

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Background

In London (and rest of UK) there has been recent concern over increasingly widespread installation and use of biomass boilers (mainly wood burning)

Driven by planning guidance on on-site renewable energy.

Renewal heat incentive is likely to be a big driver post 2011 (see www.dec.gov.uk)

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Background

Abbot et al. (2007) modelled the PM10 impacts of biomass scenarios for London as defined by London Energy Partnership.

- High biomass uptake and emission – PM10 LV exceeded at background sites in central London.
- Low uptake and emissions – PM10 LV will be harder to achieve at London roadsides.

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Background

PM10 impact from biomass in London will depend on

- Uptake
- Type of biomass boilers
- Use of installed boilers

Hard to estimate impacts from installed capacity alone.

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Background - objectives

- To be able to quantify the PM from wood burning in London.
- To provide a base line against which future studies can be done

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Method 1 Light absorption

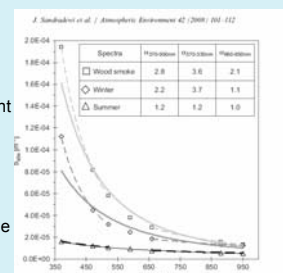
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Method -1

Favez et al., (2009) – Paris (also Sandradewi et al., 2008a, 2008b)

- PM from wood burning has different optical properties compared with PM from traffic and other urban sources.
- PM from wood burning changes the relative UV to IR absorption in PM samples

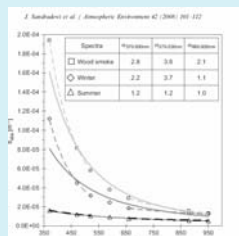


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Method -1

- Aethalometers installed in London as part of Defra black smoke network.
- UV 370nm and IR 880nm wavelengths
- Opportunity for non quantitative assessment
- Calculate coefficient α which describes wavelength dependence of absorption

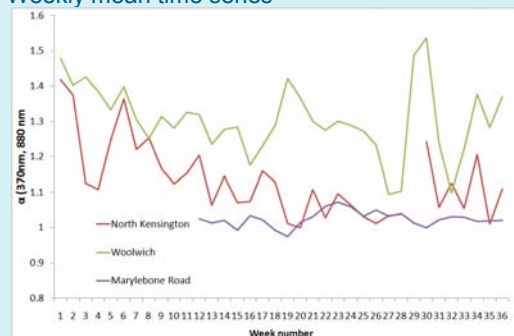


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Results – 1

Weekly mean time series

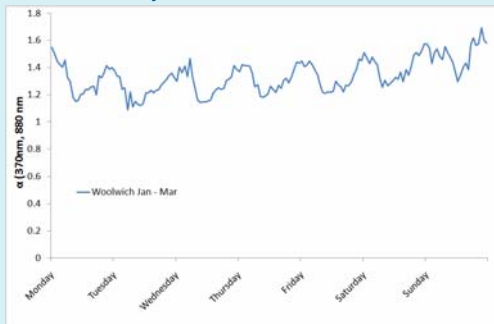


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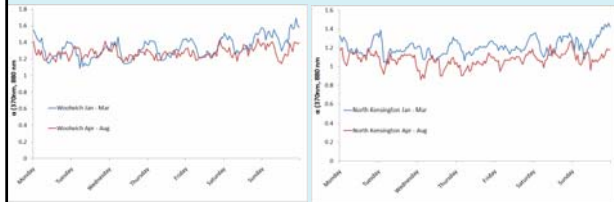
Results – 1

Diurnal and day of week



Results – 1

Diurnal and day of week winter and summer.



Method 2 Levoglucosan

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Method -2

Yttri et al. (2005); Simoneit et al., (1999); Fine et al., (2004) and others.

- PM from cellulose (wood and paper) combustion is associated with emissions of levoglucosan (a sugar).
- Emitted in high concentrations, not present in vapour phase, not selectively removed from the atmosphere. Can therefore be considered a good tracer for wood combustion PM.
- Emission rates depend on type of wood.

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Method -2

Sampling

- 3 sites over 6 weeks
- Middle of heating season.
- Samples collected using Partisol
- Greenwich 4
- Greenwich 7 (roadside)
- Bexley 2



Analysis

- Levoglucosan by HPLC/HRMS at NILU, Norway
- IR absorption by transmissometer at King's for elemental carbon

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Method -2

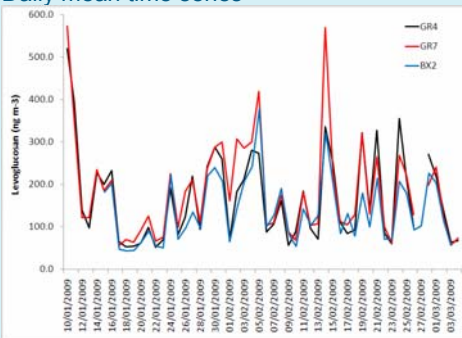


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Results -2

Daily mean time series

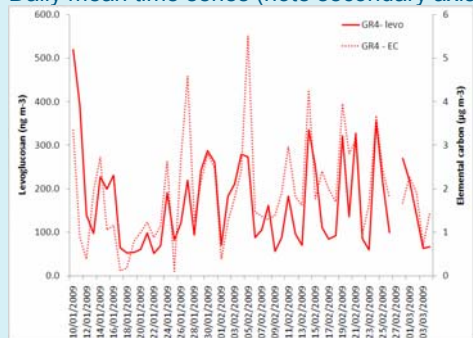


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Results -2

Daily mean time series (note secondary axis)

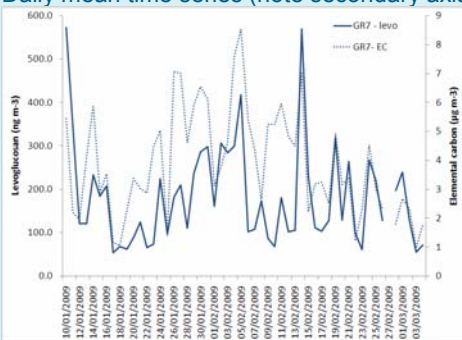


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Results -2

Daily mean time series (note secondary axis)

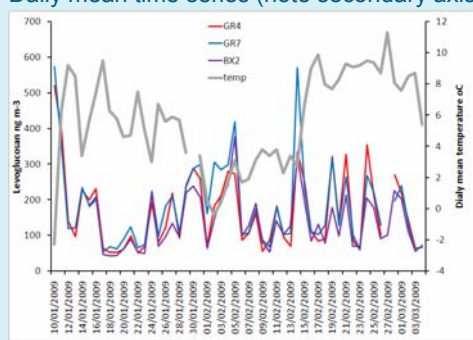


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Results -2

Daily mean time series (note secondary axis)



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Results -2

Mean levoglucosan concentration

Bexley 2	-	138 ng m ⁻³
Greenwich 4	-	167 ng m ⁻³
Greenwich 7	-	183 ng m ⁻³

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Results -2

Mean concentration

So what does this tell us about the PM10 concentration from wood combustion in London?

Levoglucosan : PM OC emission rates depend on wood type.

- Emission rates of about **1:7.5** suggested by Puxbaum et al., (2007) and Fine et al., (2002a).
- Newer work suggests **1:11** to **1:18** Yttri et al., (2009).
- Used **1:10** for initial calculation in this study.
- Then multiply OC to mass **1:1.4** suggested by Puxbaum et al., (2007)

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Results –2

Mean concentration

But elemental carbon emissions too...

Yttri et al., (2009) suggest emissions ratio **1:4** based on ambient measurements.

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Results –2

Mean concentration

During mid winter time study period

Suggests PM10 from wood smoke $\sim 3 \mu\text{g m}^{-3}$

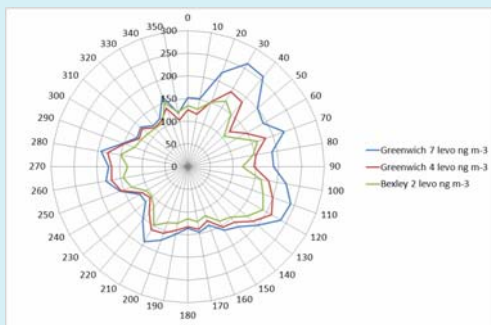
Mean PM10 (FDMS) (3 sites) $25 \mu\text{g m}^{-3}$

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Results –2

Where's it coming from? Wind direction analysis

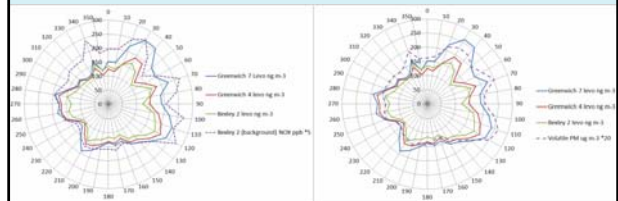


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Results –2

Where's it coming from? Wind direction analysis

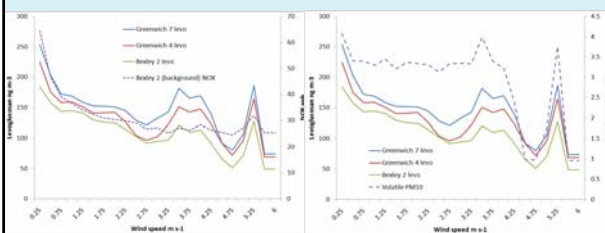


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Results –2

Where's it coming from? Wind speed analysis



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Conclusions

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Conclusions

Two different techniques provide evidence for PM from wood burning in London.

Assuming traffic emissions are constant, light absorption suggests a wintertime source of PM which is greatest during:

- Weekends - afternoon and evening.
- Weekday evenings to a lesser extent.
- Care with respect to PM from traffic

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Conclusions

Levoglucon measurements

This study can be used as a baseline for future work.

Suggest PM10 from wood burning ~ $3 \mu\text{g m}^{-3}$ during wintertime study vs mean PM10 of $25 \mu\text{g m}^{-3}$.

Light absorption measurements suggest this may be a winter (Jan to Mar) effect. Therefore contribution to annual mean PM10 ~ 0.75 g m^{-3} ?

(Wood smoke will be almost all PM2.5 – exposure reduction)

PM10 from wood burning appears to be a diffuse London source. Coupled with light absorption analysis this suggests **domestic wood burning in existing fire places**.

If we were to assume about 1/3 of PM10 in London arises from sources in the capital then biomass is already a big proportion of London's emissions. Is this realistic?

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Programme for 2010

Six site measurement programme
(Same period and sampling protocols as 2009 study.)

Biomass 'hot-spot' site.

Two sites from 2009.

Additional sites to increase spatial coverage.

Funded by Defra air quality grant in conjunction with Islington and other London boroughs.

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Thanks...

London boroughs of Greenwich and Bexley for having the foresight to fund the Levoglucon measurements.

Jean Sciare, Laboratoire des Sciences du Climat et de l'Environnement for an excellent presentation on PM in Paris at the summer AirParif scientific advisory meeting.

Defra and our NPL partners (especially David Butterfield) in the black smoke network for the absorption measurements.

Lynette Clapp for transmissometer measurements

Ian Mudway for health effects references

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