Monitoring Ambient Air 2014

Air Quality in Europe
- New Challenges

Conference with
Posters and Exhibition

Organised by the
Automation and Analytical Management Group -
Royal Society of Chemistry

Tuesday 9th & Wednesday 10th December 2014

At The Royal Society of Chemistry,
Burlington House, Piccadilly,
London W1J 0BA

Email: conference@aamg-rsc.org
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RSC | Advancing the Chemical Sciences

Air Quality in Europe
- New Challenges

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Tuesday 9th and Wednesday 10th December 2014
at The Royal Society of Chemistry, Burlington House, London

Day 1 - Tuesday, 9th December 2014

09:30 Registration

10:25 Welcome and Introductory Remarks

Session 1: AQEG

Chair: **Paul Monks**, Chair of AQEG, University of Leicester, UK

10:30 Impacts of Shipping on UK Air Quality
David Carruthers
AQEG, Cambridge Environmental Research Consultants, UK

11:00 The Potential Air Quality Impacts from Biomass Combustion in the UK
Alison Tomlin
AQEG, University of Leeds, UK

11:30 Effectiveness of NO_x Removing Paint
David Carslaw
AQEG, King's College London, UK

12:30 Short Presentations by Exhibitors

13:00 Lunch - Exhibition & Posters

Session 2: Air Pollution Aspects of Shale Gas Extraction

Chair: **Paul Monks**, Chair of AQEG, University of Leicester

14:00 Shale Gas Extraction in the UK
Chris Dore
AQEG, Aether, UK

14:30 Fracking in the UK: Impacts of Secondary Oxidants on Air Quality and Radiative Forcing
Alexander Archibald
University of Cambridge, UK

15:00 Shale Gas: Dealing Effectively with Emissions to Air
Mark Broomfield
Ricardo AEA Ltd, UK

15:30 Tea / Coffee - Exhibition & Posters

Session 3: Emerging Pollution Sources

Chair: **Paul Quincey**, National Physical Laboratory, UK

16:00 Using Metals Emissions Ratios to Detect Emissions from Municipal Waste Incinerators in Ambient Air Pollution Data in the United Kingdom
Anna Font
King's College London, UK

16:30 Shipping Emissions in the Port of Oslo: Inventory, Mitigation Strategies and Future Scenario
Susana López-Aparicio
Norwegian Institute for Air Research, Norway

17:00 End of Day One

Day 2 - Wednesday, 10th December 2014

09:30 Tea / Coffee - Exhibition and Posters

Session 4: Black Carbon and Diesel Exhaust

Chair: **Gary Fuller**, King's College London, UK

10:00 Black Carbon as Indicator of Adverse Health Effects of Urban Air Pollution
Aurelio Tobias
C S I C, Spain

10:30 Characterisation of SVOC from Diesel Exhaust Emission using GC×GC-ToF-MS
Mohammed Salim Alam
University of Birmingham, UK

11:00 Source Specific Spatial and Temporal Heterogeneity of Black Carbon – Consequences for Abatement Measures
Asta Gregoric
University of Nova Gorica, Slovenia

Session 5: The CARBOTRAF Project

Chair: **Guy Kouwjzer**, E T S, Belgium

12:00 Correlation of Black Carbon Emissions and Concentrations with Traffic in the Project CARBOTRAF
Martin Litzenberger
Austrian Institute of Technology, Austria

12:30 CARBOTRAF: A Decision Support System for Reducing CO_2 and Black Carbon Emissions by Adaptive Traffic Management:- Evaluation Based on Simulated and Measured Data
Martine Van Poppel
VITO, Mol, Belgium

13:00 Lunch - Exhibition & Posters

Session 6: Advances in Air Pollution Measurement

Chair: **Theo Hafkenscheid**, RIVM, The Netherlands

14:00 Comparison of a Semi-Continuous Analyser Against a Manual Method for Measuring Anions and Cations in PM_{10}
Sonya Beccaceci
National Physical Laboratory, UK

14:30 Understanding the Impact of Chemical Composition and Meteorology on Highly Time Resolved Measurements of $PM_{2.5}$ Mass
David Green
King's College London, UK

15:00 Assessing Variations in Roadside Air Quality with Sampling Height
Stephen Stratton
Ricardo AEA Ltd, UK

15:30 Tea / Coffee - End of Conference

ABSTRACTS

Impacts of Shipping on UK Air Quality

David Carruthers

AQEG, Cambridge Environmental Research Consultants, UK

ABSTRACT

Shipping is a growing sector dependent on fossil-fuel combustion, but one of the least regulated sources of anthropogenic emissions. Shipping makes significant contributions to emissions of atmospheric pollutants, in particular to NO_x and SO_2 gases, primary $PM_{2.5}$ and PM_{10} particulate matter, including black carbon, and CO_2. Chemical reactions in the atmosphere involving NO_x and SO_2, and NH_3 gas emitted from land sources, lead to the formation of components of secondary inorganic particulate matter. These primary and secondary pollutants contribute both to adverse human health effects and to environmental damage through acidification and eutrophication.

The presentation details the recent study on shipping impacts on air quality conducted by AQEG providing a UK perspective on the impact of shipping on UK air quality. The general areas addressed are:

- What are the quantitative impacts of shipping on UK air quality, including deposition to the UK? Is there any evidence of air quality exceedances being driven predominantly by shipping emissions? Is there empirical evidence of changes to UK air quality from historic changes to shipping emissions?
- Are current measurement strategies sufficient to identify shipping emissions trends going forward?
- What are the requirements and challenges for shipping emissions inventories?
- Are considerations of the UK climate and air quality impacts of shipping integrated?

The presentation first considers the regulatory framework, followed by sections on emission inventories, measurements and modelling, and concludes with a discussion on air quality and climate change issues.

The Potential Air Quality Impacts from Biomass Combustion in the UK

Alison S. Tomlin and AQEG committee members

ABSTRACT

Biomass combustion is increasing both as a result of government incentives to encourage the use of renewable low carbon fuels for power and heat generation, and because it can lower domestic fuel costs where the wood/biomass is recovered locally in response to fuel poverty issues. Domestic wood burning may also be increasing for the provision of secondary heating within urban areas as part of a part of a lifestyle choice since it is considered to be a renewable and therefore "Green" fuel. A recent EEA report suggested that burning biomass for home heating increased by 56% between 1990 and 2011, raising potential concerns for impacts on human health due to the resulting pollutant emissions. Biomass is also being increasingly used within district heating and combined heat and power (CHP) schemes at the city scale, as well as being co-fired for electricity production within UK power stations. AQEG is currently investigating whether such changes in fuel usage are likely to impact on UK air quality. The main findings to date will be reported within the presentation.

The combustion of biomass leads to a broad range of pollutants including NO_x, particulates (predominantly in the $PM_{2.5}$ fraction), and a complex mixture of VOCs including PAHs and dioxins. The composition and scale of emissions from biomass combustion will be highly variable and depends on a range of factors such as:

- scale and operation of combustion technology which affects mixing and oxygen availability and therefore particulate and NO_xformation
- mitigation measures installed, which to a large extent are driven by legislative requirements
- quality of the wood/biomass including moisture content and pre-treatment
- trace components within the fuel such as nitrogen, potassium, chlorine etc.

Biomass burning activity data used in the development of the National Atmospheric Emissions Inventory (NAEI) suggests that there are increasing emissions of PM, NO_x, BaP and dioxins from biomass source categories at a range combustion scales. Where these increases represent fuel switching from gas to

biomass (e.g. for domestic or community scale heating or CHP) these could represent an overall increase in UK emissions. Where fuel switching is from coal or from oil the impact is likely to be lower or negative depending on the relative emissions factors for the fuels and combustion efficiencies. The report finds that emissions from large-scale sources such as from co-firing within power stations can be estimated with lower uncertainties than for smaller scale sources. The data for domestic scale combustion is highly uncertain; being currently informed by national scale data such as fuel supply rates and limited survey data. Bearing in mind these uncertainties, domestic sources of pollution from biomass are estimated to be increasing.

Ambient air quality studies which can specifically identify pollution due to biomass burning are fairly scarce. Several fingerprint compounds such as levoglucosan, retene and potassium can be used to estimate the biomass contribution to ambient PM. Currently, such measurements are mainly available from short term measurement campaigns and therefore it is difficult to assess the long term trends in the atmospheric loading of PM due to biomass. Short term measurements suggest a strong seasonal signal in these tracer compounds which indicates sources related to heat provision. Studies performed by Fuller et al (2014) and as part of the ClearfLo campaign suggest an annual mean contribution of wood smoke to PM_{10} of around 1 μg m^{-3} in London. Retene measurements within several large UK cities show a trend in increasing winter peaks.

In summary, whilst significant uncertainties exist within estimates of the impact of biomass combustion on air quality, overall there is probably sufficient evidence to suggest that it is increasing and needs to be considered within strategies aimed at reducing climate change impacts.

Effectiveness of NO_x Removing Paint

David Carslaw

King's College London

ABSTRACT

There is increased interest in the use of photocatalytic surfaces that contain titanium dioxide (TiO_2) as a way in which to reduce concentrations of pollutants such as NO_x. The use of these surfaces is attractive in many ways – chiefly through providing a relatively cheap way in which to reduce the concentration of pollutants such as NO_2 that are currently proving difficult to manage. The efficacy of these materials in reducing concentrations of NO_x is however difficult to quantify. First, these materials can lead to a wide range of surface chemical reactions with the potential to produce other species that can have wider implications for atmospheric chemistry. Second, in urban-type environments it can be difficult to robustly evaluate the effectiveness in these paints for reducing pollutant concentrations. This talk will consider the recent evidence related to the use of these materials that will form the basis of an Air Quality Expert Group report.

Shale Gas Extraction in the UK

Chris Dore
Aether, Oxford

ABSTRACT

Shale gas extraction ("fracking") in the UK is still in the exploratory phase, and there is large uncertainty regarding the future scale of gas production, and associated emissions to air. Projections indicate that the number of wells constructed by 2028 might be 190, 400 or 810 in corresponding low, medium and high scenarios.

Using data from the USA, average annual emissions have been estimated for the medium scenario (400 wells) in the UK. The contribution of emissions from shale gas wells (and associated machinery)to the UK emissions totals for NO_x, NMVOCs, and PM have been estimated. However, extraction activities would be concentrated in specific regions of the UK, and it would therefore be necessary to monitor emissions at a local scale to assess the impact on localised air quality, and also on regional ozone formation.

The reasons for the high levels of uncertainty in estimating projected growth and associated emissions to air is that it is not simple to draw on the recent experience in the USA and apply it to the UK. There are fundamental differences in the geology between the USA and the UK – the UK shale basins being smaller, more fragmented, harder to fracture, and at substantially greater depths. As a result the extraction methods utilised need to be different to those used in the USA. In addition, the regulatory framework in the UK (the same as that for conventional gas) is considered to be more stringent than that of the USA, and is therefore expected to be more effective at controlling emissions.

The potential for air emissions to impact on ozone levels will strongly depend on local conditions, but measurement in the USA have indicated that extraction activities might contribute 12% to regional ozone emissions in 2020. In addition, it has been noted that shale gas operations may result in ozone formation in rural areas where the necessary mix of precursors did not previously occur. However, it is challenging to interpret the evidence base on ozone formation from the USA in the context of the UK situation.

A few studies in the USA have investigated the health impacts of air emissions associated with shale gas extraction activities, although as the industry is relatively new, peer-reviewed research on the public health impacts is somewhat scarce. This is expected to increase in the future as shale gas activities occur increasingly close to residential areas, and to attempt to address public concern of health risks. No studies have yet been performed in the UK.

Monitoring programmes for methane and other gaseous pollutants will be required to fully assess the impacts of the extraction activities on the local air quality, prior to drilling (to characterise the background levels), during drilling (to identify leaks) and after closure of the well (as part of the maintenance programme).A range of measurement techniques are already available to meet these demands, and requirements are already included in the UK regulatory framework.

Fracking in the UK: Impacts of Secondary Oxidants on Air Quality and Radiative Forcing

Alexander T. Archibald, Edward Brent,
Paul T. Griffiths and Amanda C. Maycock

University of Cambridge, Department of Chemistry and National Centre for Atmospheric Science – Climate

ABSTRACT

Hydraulic fracturing (fracking) as a means of extraction of gaseous hydrocarbons from shale has been widely purported as being an aid to self-sufficiency for energy demand within the British Isles and potentially Western Europe. Whilst arguments for fracking generally focus on economics, arguments against fracking include impacts to water quality and aquatic systems as well as subsidence and associated impacts on commercial and private properties. In a very densely populated nation such as Great Britain it's paramount to investigate all potential deleterious effects of any new technologies. In this study we focus on the impacts that the life cycle of hydraulic fracturing can have on the atmosphere – specifically focusing on impacts to the UK. We use a range of prognostic numerical models to simulate how emissions of hydrocarbons and oxides of nitrogen (NOx) associated with fracking (from extraction to combustion as well as leakage and transportation) will impact levels of ozone (O_3) in the lower atmosphere. As well as being a principal component of photochemical smog, O_3 is also a potent greenhouse gas. By using a state-of-the-art chemistry climate model, the UM-UKCA, we are able to scale up the impacts that fracking can have on local air quality to the hemispheric and global scales and so estimate any potential impacts fracking in the UK will have on climate change.

Shale Gas: Dealing Effectively with Emissions to Air

***Mark Broomfield*[1],** Thomas Buckland[1] and James McGarry[2]

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ABSTRACT

Shale gas development is the subject of considerable interest in the UK. While there is interest in developing shale gas resources (with evidence for substantial gas and oil resources; the offer of tax breaks; and the launch of the recent 14th Onshore Licensing Round by DECC), there is also concern about potential environmental risks and impacts.

Similar issues are being addressed in the State of Maryland, but with greater urgency, as the State authorities will soon decide whether to permit shale gas development in Maryland. This paper describes an analysis of the environmental risks associated with the possible development of Marcellus Shale Gas in Maryland (available from **http://chesapeakeclimate.org/maryland/fracking/)**, with particular focus on potential local and regional air quality impacts. The study considers wellpad emissions as well as impacts from traffic and downstream infrastructure, and identifies that cumulative impacts of developing a shale gas field could potentially pose a high risk to air quality if appropriate steps are not taken.

As part of the Maryland state decision-making process, a detailed set of "best practice measures" for controlling environmental impacts have been published. This paper will go on to describe the effectiveness of these BPMs, leading to a revised evaluation of impacts of emissions to air. This analysis found that full implementation of BPMs would result in reduced risks of air quality impacts, although risks were still ranked as moderate.

Finally, the paper will consider how these findings can be applied to the development of the UK's shale gas and oil resources.

Using Metals Emissions Ratios to Detect Emissions from Municipal Waste Incinerators in Ambient Air Pollution Data in the United Kingdom

***Anna Font**,** Kees de Hoogh[2,3,4], Maria Leal-Sanchez[4], Danielle C. Ashworth[5], Richard J. C. Brown[6], Anna L. Hansell[4,7] and Gary W. Fuller[1]

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ABSTRACT

In this study we aimed to fingerprint emissions from six Municipal Solid Waste Incinerators (MSWIs) and then test if these fingerprint ratios could be found in ambient air samples. Stack emissions tests from MSWIs comprised heavy metals and those pairs of metals showing good correlation were taken as tracers of MSWI emissions and ratios calculated: Cu/Pb; Cd/Pb; Cd/Cu and Cr/Pb. Emissions ratios from MSWIs differed significantly from those in ambient rural locations and close to traffic. In order to identify MSWI emissions in ambient air two tests were carried out: the first, aimed to explore if MSWI emissions dominate the ambient concentrations; the second, examined occasional plume grounding and tested if all four ratios differed from rural or traffic values at the same time and were consistent with MSWI emissions. From our analysis we found no evidence of MSWI emissions in ambient metal concentrations around four UK MSWIs. Metal ratios consistent with MSWI emissions were found in ambient air within 10 km of one MSWI for about 0.2% of study period. Emissions consistent with a second MSWI were similarly detected at two ambient measurement sites, about 0.1% and 0.02% of the time. Where plume grounding was detected, the annual mean particulate matter (PM) from the MSWI was estimated to be between 0.029 μg m^{-3} and 0.123 μg m^{-3}, 2-3 orders of magnitude smaller than background ambient PM_{10} concentrations. This study concludes that the six UK MSWIs studied contributed little to ambient PM_{10} concentrations.

Shipping Emissions in the Port of Oslo: Inventory, Mitigation Strategies and Future Scenario

Susana López-Aparicio[1*], Dag Tønnesen[1], The Nguyen Thanh[2], Heidi Neilson[3]

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ABSTRACT

Air pollutants (NO_x, PM_{10}, SO_2) and greenhouse gases (GHG; CO_2, CH_4, N_2O) emissions associated with shipping activities in the port of Oslo have been estimated for 2013 and 2020 following a bottom-up approach. The detailed emission inventory shows that oceangoing vessels are the main contributor with about 63-78% of the total emissions of NO_x, PM_{10}, $SO_2$and CO_2. International ferries, tourist cruises and container vesselsare the main contributors among the oceangoing vessels withabout30-35%, 19-22% and 5-8% of the total emissions, respectively. Among the harbour vessels, domestic ferries and excursion boats are the main contributor(10-19%). Emissions from oceangoing vessels werealso appraised for different operational modes, obtaining the highest emission levels at berth followed by emissions during manoeuvring. Mitigation measures were evaluated based on the detailed emission inventory and the knowledge concerning the main contributing sectors. Onshore power is an effective measure to reduce air pollutants and GHGs emissions from shipping in the port of Oslo. Emission reductionsup to 13%, 34%and 53% are obtainedwith the implementation and use of onshore power by 1) international ferries,2) international ferries andtourist cruises, and 3) international ferries, tourist cruises and containers vessels, respectively and regarding a current situation.A 2020-scenario was developed taking into account the compliance with the new directive regarding a sulphur content in marine fuel below 0.1%. The results from our study show that the compliance with the directive involves a reduction of about 90% and 10% in SO_2 and PM_{10} emissions, respectively.

Black Carbon as Indicator of Adverse Health Effects of Urban Air Pollution

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ABSTRACT

Current air quality standards for urban air pollution mainly use mass concentration of the particulate matter with aerodynamic diameters ≤2.5 μm ($PM_{2.5}$) and ≤10 μm (PM_{10}) as metric. It has been suggested that particles from combustion sources are more relevant to human health than particles from other sources. However, few studies have assessed for adverse health effects of black carbon particles (BC) as an additional in air quality indicator, mainly in US.

We investigated the short-term effects of BC on total daily mortality in the city of Barcelona (Spain), between January 2009 and December 2011, using a time-stratified case-crossover design. Results are compared with those obtained with the usual indicators of PM mass ($PM_{2.5}$ and PM_{10}).

Estimated health effects of an interquartile range increase were greater for BC than for $PM_{2.5}$ and PM_{10}. An increase of 1.4 μg/m^3 in BC increased mortality by 3%, while an increase of 10.5 μg/m^3 in $PM_{2.5}$, and of 17.0 μg/m^3 of PM_{10}, increased mortality by <1%. Two-pollutant models showed that effect of the BC was more robust than effect of the PM mass.

BC could be a valuable additional air quality indicator to evaluate the health risks of air quality dominated by primary combustion particles.

Characterisation of SVOC from Diesel Exhaust Emission using GC×GC-ToF-MS

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ABSTRACT

Despite intensive research over the last 20 years, major questions remain concerning the composition of primary vehicle exhaust aerosol and its contribution to secondary organic aerosol (SOA) formation. These uncertainties relate especially to the semi-volatile component of the particles. Semi-Volatile Organic Compounds (SVOC) are compounds which partition directly between the gas and aerosol phases under ambient conditions. In engine exhaust the SVOC are typically hydrocarbons in the C_{15}-C_{35} range and are largely uncharacterised, other than the *n*-alkanes. This is due to the drawbacks of monitoring techniques available, as the SVOC are unresolved by traditional gas chromatography and form a large hump in the chromatogram referred to as Unresolved Complex Mixture (UCM).

In this study,we exploit 2D Gas-Chromatography Time-of-Flight Mass-Spectrometry (GC×GC-ToF-MS) to characterise and quantify the composition of SVOC from diesel exhaust emission. The GC×GC-ToF-MStechnique has been demonstrated capable of resolving specific components of the UCM, which typically makes up 95% of the area of chromatogram using conventional 1D separation. Samples were collected from the exhaust of a diesel engine with and without abatement devices fitted. Engine exhaust was diluted with air and collected using both filter and impaction (MOUDI), to resolve total mass and size resolved mass respectively.The SVOC was observed to contain predominantly *n*-alkanes, alkyl-cyclohexanes, alkyl-cyclopentanes and aromatics; similar to both fresh lubricating oil and fuel. Differences were also observed in the SVOC composition when using different fuel types, engine lubricants, starting temperatures and collecting samples with and without abatement devices fitted.

Source Specific Spatial and Temporal Heterogeneity of Black Carbon – Consequences for Abatement Measures

***Asta Gregorič*[1]**, Luka Drinovec[2], Irena Ježek[2], Ivan Iskra[2], Magdalena Kistler[3], Eylem Cetintas[3] 4, Heidi Bauer[†3], Anne Kasper Giebl[3], Griša Močnik[2]

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ABSTRACT

We performed measurements with Aethalometers and filter sampling at different locations in and around three central European cities of different sizes: Klagenfurt, Maribor, and Ljubljana. The measurements lasted three consecutive winters in two cities and we performed several campaigns in the third city. All three cities are situated in basins and experience frequent severe pollution episodes in winter. Measurement of aerosol absorption allows highly time-resolved source apportionment (Sandradewi, 2008), and results of chemical filter analyses can be used to apply the macro-tracer model (Kistler, 2013), both for the determination of wood burning and traffic to particulate air pollution. We compare different source apportionment methods for Black Carbon (BC) and carbonaceous matter, and show a good agreement between on-line source apportionment using the Aethalometer model and the off-line macro-tracer model. We demonstrate the drastically different spatial and temporal heterogeneity of BC apportioned to traffic and wood burning for all three cities. The measurement results show that wood smoke is spatially homogeneous on a regional scale, while traffic contributes locally. The results indicate that socio-economic factors play an important role in the selection of fuel for domestic heating. We were able to assess the efficiency of the abatement policy related to traffic and show the necessity of drastic measures. Wood burning appears to be on the rise in urban areas, prompting inclusion of this source in local and regional regulation of air pollution.

Sandradewi J. et al. (2008), Using Aerosol Light Absorption Measurements for the Quantitative Determination of Wood Burning and Traffic Emission Contributions to Particulate Matter, Enviro. Sci. & Tech. 2008, 42 (9), 3316-3323.

Kistler M. et al., Analysis of filters for chemical parameters and identification of gaseous nitric acid and nitrates in particles from filtersets for the PMinter project. (2013) Report, CTA-EAC-10/13-5, Institute of Chemical Technologies and Analytics, Vienna University of Technology.

Correlation of Black Carbon Emissions and Concentrations with Traffic in the Project CARBOTRAF

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Schramm M,IBM Österreichische Büromaschinen GmbH, Mascia M, North R,
Imperial College London, Van Poppel M, VITO B.V.

ABSTRACT

The CARBOTRAF decision support system utilizes intelligent transportation systems (ITS) actions, such as adaptive VMS route advices and traffic signal control to reduce traffic emissions in an urban area. The system supplies traffic operators with real-time proposals for ITS actions and their predicted impact on overall emissions to support them in making an informed decision. Together with the proposed action the expected impact on CO_2 and BC emissions as well as on traffic are presented to the operator. The system is tested in real-time operation in Graz and Glasgow.

Congestion with start/stop traffic is know to have an increased overall emission compared to free flowing traffic. The CARBOTRAF system tries to assess the current traffic situation from real-time measurements and propose actions to improve traffic flow and thereby reduce emissions. ITS actions investigated in the project are traffic rerouteing via alternative routes to balance the traffic load in the area, supported by modified traffic signal control.

Analysis of the traffic simulations results and the traffic and air quality measurement data collected during the test operations show a potential to reduce the traffic related emissions by reducing the start/stop cycles. The evaluation of the impact of the real-time system is done, among other methods, by measuring the frequency of start/stop cycles in the spill back zones of major intersections in the test area. The correlation of a simple model for traffic emission source strength including start/stop frequency correlates well with the observed roadside black carbon concentrations.

CARBOTRAF: A Decision Support System for Reducing CO_2 and Black Carbon Emissions by Adaptive Traffic Management: evaluation based on simulated and measured data

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ABSTRACT

The CARBOTRAF system is a DSS (decision support system) for traffic optimization. The system combines real-time monitoring of traffic with simulation models for the prediction of CO_2, BC (black carbon) emissions and air quality to provide on-line recommendations for alternative traffic management. The system is tested in the cities Graz and Glasgow. ITS actions investigated in the project are traffic rerouting via VMS (variable message sign) and modified TSC (traffic signal control).

The impact of the CARBOTRAF system is evaluated for different KPI (Key Performance Indicators) e.g. travel time, delay, CO_2 and BC emissions and BC roadside concentrations. Data are available from micro simulation models (traffic and emission), dispersion models and predicted values (from the DSS : Decision Support system). In addition, the system is evaluated based on data from BC monitors and traffic sensors installed at the test site.

Micro simulation models show a positive impact of ITS actions on emissions, pollutant concentrations and travel time in both test sites. BC emissions can be reduced up to 5% on network level and can be higher on junction or corridor level. Improvements of traffic parameters (e.g. travel time or delay) mostly coincidence with improvements in emissions. However, detailed analysis shows the complex impact of vehicle dynamics on emissions. Simulations show potential changes of ITS actions on BC annual average concentrations up to -0.3 µg/m^3. Moreover, maximal reduction of BC concentrations up to 2 µg/m^3can be possible for specific meteo conditions. Simulations show that impact of ITS measures is function of initial traffic state and meteo.

Real time measurements acquired during the reference period show that BC is a good indicator to evaluate the impact of traffic. BC concentrations show similar daily patterns as traffic numbers. However increased concentrations also correspond to increased acceleration ratio measured. This indicated that both parameters define emission profiles. Results from simulations and real-time measurements will be discussed.

Acknowledgement

The research leading to these results has received funding from the European Union Seventh Framework Programme FP7/2007-2013 under grant agreement n° 287867.

Comparison of a Semi-Continuous Analyser Against a Manual Method for Measuring Anions and Cations in PM_{10}

***Sonya Beccaceci*[(1)]**, Elizabeth A. McGhee[(1)], Richard J.C. Brown[(1)] and David C. Green[(2)]

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ABSTRACT

The National Physical Laboratory has been running the UK Particle Counting and Speciation Network on behalf of Defra since 2005.

One of the aims of this Network is to generate reliable datasets of airborne particle number concentration and size at selected sites. Long-term time series measurements of particle number are important for epidemiological studies, while size distributions provide important additional information on the processes involved in particle formation, evolution and fate.

A further aim is to provide information on the chemical composition of particulate matter, like organic carbon and elemental carbon (OC/EC) content and anion and cation concentrations.

This work focuseson the use of theURG 9000B Ambient Ion Monitor to measure airborne anion and cation species with hourly time resolution. This instrument is usually operatedwith a $PM_{2.5}$ cyclone,but here the instrument was usedwith a size selective PM_{10} monitoring head.Therefore, a first comparisonbetween this analyser and the manual filter-based technique for measurement of ions in PM_{10} will be presented. The two methods showed good correlation for nitrate, sulphate, chloride, ammonium and magnesium but a much poorer correlation for sodium, potassium and calcium. Possible instrument artefacts, such as positive bias within the sampling unit and issues with the efficiency of the particle extraction will be discussed as causes of poorer comparability, and further work to resolve these matters will be suggested.

Overall, the automatic analyser was found to provide very useful information of the ionic composition of PM_{10} in urban sites.

Understanding the Impact of Chemical Composition and Meteorology on Highly Time Resolved Measurements of $PM_{2.5}$ Mass

***David Green*[1],** Max Priestman[1] and David Butterfield[2]

[1] King's College London, [2] National Physical Laboratory

ABSTRACT

This study compares the different $PM_{2.5}$ mass measurement technologies (EU reference method, FMDS and BAM) at daily and hourly time resolution to investigate how PM chemical composition and meteorological conditions impact on the measured mass. This has important implications for the design of monitoring networks in the future.

Two datasets were generated to understand the factors affecting the measurements during spring 2014 in Teddington, UK.

a) Chemical composition of $PM_{2.5}$

Understanding the response of instruments in real time to the volatile components of PM, such as ammonium nitrate, ammonium chloride and organic compounds, can highlight differences between the drying methodologies and particle collection efficiencies; especially during peak episode conditions. To achieve this, the full chemical composition was measured at a high time resolution (30 min means) using a combination of Aerosol Chemical Speciation Monitor (ACSM) and Aethalometer; together these have been demonstrated to account for the total mass of $PM_{2.5}$.

b) Meteorological measurements (ambient temperature and dew point temperature)

Meteorological factors influence the measurement of PM in a number of ways. For instance, temperature and dew point temperature (as well as chemical composition) are important factors in determining the water content of PM and therefore how efficient the dryer needs to be to remove the particle-bound water. These parameters are used to control the variable heating of some sample inlets. Of particular interest was the susceptibility of the volatile PM to this variable heating as a method of drying; this was especially important during periods of elevated ammonium nitrate concentrations.

Assessing Variations in Roadside Air Quality with Sampling Height

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ABSTRACT

A wide range of air quality monitoring is undertaken by the Scottish Government to fulfil the requirements of EU Directive 2008/50/EC on ambient air quality, and by local authorities under the Local Air Quality Management regime (LAQM) as set out in the Environment Act 1995 and associated regulations.

Although both the Directive and LAQM are focused towards protecting human health, current monitoring strategies fail to consider variations in air quality with height above the ground. Heights of monitoring station sampling points vary depending on local conditions and with type of equipment installed. As most vehicle emissions tend to occur less than 1 m above ground, current sampling may not adequately reflect horizontal variations in air quality.

A mobile air quality platform has been developed to measure a number of pollutants atchild buggy height (0.8m) and adult height (1.68 m) simultaneously, including black carbon, ultrafine particles (10 – 300 nm), particulate matter (0.3 - 10 μm) and nitrogen dioxide in addition to recording meteorological conditions, GPS and video.

Thestudy was carried out in Glasgow City Centre over a 6 month period and investigates how air quality varies between the two sampling heights. The study aims to determine the relationship between height from pavement and air quality; investigate the relationship between mobile and fixed sampling methods; and examines diurnal and seasonal variations in air quality.The outputs will be usedto inform air quality policy in Scotland.

POSTER ABSTRACTS

Impact of Green Screens on PM_{10} and NO_2 Concentrations in Near Road Environments

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POSTER ABSTRACT

Research relating to green infrastructure suggests that it is a cost effective and easy way to reduce the impact of pollution on people, particularly near roads. Children are especially vulnerable to impacts of pollution as their lungs are still developing. Thus a measure to reduce pollution concentrations in schools situated close to roads would be of particular benefit and has been investigated in this study.

In order to assess whether there is a reduction, ivy screens were installed at a primary school in Kensington & Chelsea in London, chosen as it is situated next to roads with large traffic volumes. PM and NO_2 concentrations were being measured on either side of the screen using an Osiris analysers (based on light scattering) and a standard chemiluminescent analysers, respectively.

The expected concentration differences between roadside and schoolyard are small and need to be distinguished from the sampler uncertainty, which was assessed by co-locating the samplers for a period of time and calculating the between instrument uncertainties. It was calculated that the hourly means of NO_2 at the Kensington & Chelsea an uncertainty of 23% (2σ). Preliminary results from Kensington & Chelsea show that with growing screen thickness the concentration difference between the two NO_2 samplers was greater than these uncertainties; thus there was a significant effect of the green screen. Similar calculations will be performed for the PM concentrations and final results will be shown and the effects the green screens evaluated further.

Monitoring Ship Emissions with Theanatmospheric Observatory at Penlee Point, Cornwall

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POSTER ABSTRACT

We present a new ground-based atmospheric observatory at a coastal site on the Rame Peninsula, ~6km south-west of Plymouth. At the mouth of the Plymouth Sound, the Penlee Point Observatory (PPO) is ~8m above mean sea level and ~30m from the high tide mark. The PPO is mains powered and uses line-of-sight radioethernet to communicate data back to the laboratory. All sensors and inlets are mounted at the top of a 12m retractable mast (~20m above sea level). Measurements are continuous and include meteorology (wind speed and direction, pressure, humidity, air temperature, dew point, rain rate) and atmospheric concentrations of sulfur dioxide, ozone, carbon dioxide and methane. We routinely sample particulate trace metals and nutrients with a high volume sampler mounted on the observatory roof. The site is exposed to marine air masses when the wind sector is between 110° and 250°. Winds coming from the south and south-west (180°-240°) encounter minimal terrestrial influence and may be representative of relatively clean Atlantic air. Plymouth Sound (to the east) experiences heavy marine traffic with daily naval and commercial ship movements. We observe regular ship stack plumes as spikes in sulfur dioxide accompanied with decreases in ozone, likely driven by reaction with nitrogen oxides.The proximity of nearby marine sampling sites also makes the PPO an ideal location to study the interaction between the ocean and the atmosphere. Long term measurements at the site will allow us to examine the impact of shipping on the coastal atmosphere and ocean.

Fibre Optic Sensors for Indoor Air Quality Monitoring

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POSTER ABSTRACT

There is significant scientific evidence that inappropriate indoor air quality (IAQ) affects negatively human health. The appropriate monitoring of microclimatic parameters plays the key role in IAQ control. Greater monitoring and data evaluation can be applied to reduce the energy demands of buildings and their environmental impacts. There is a growing need for reliable and cost effective sensors to undertake such monitoring. Fibre optic sensors are a potential solution to this issue and the poster discusses their possible use for IAQ measurement and demonstrates their application by the fabrication of an array of fibre optic sensors for measuring simultaneously temperature, relative humidity and volatile organic compounds (VOCs). These factors were chosen as they are key microclimatic parameters for indoor environments.

The optical fibre sensor platform used was the long period grating (LPG), which, through appropriate surface modification, can allow the measurement of the parameters of interest. An array of three LPGs was created in a single optical fibre, multiplexed in the wavelength domain. One of the LPGs, with no surface modification was used to measure temperature. The second LPG, modified by the deposition of a mesoporous coating of silica nanospheres, was used to measure relative humidity, while the third LPG, modified again with a coating of silica nanospheres into which was infused a functional material (calixarene) was used to monitor VOCs concentration. The sensors were calibrated in the laboratory and the simultaneous measurement of the key indoor air quality elements was undertaken in two different indoor environments: laboratory and office areas, in two different buildings at Cranfield University.

The average differences between values obtained by optical fibre and standard temperature and RH sensors were better than 0.5^{o}C and 5% respectively. In these environments the VOC concentration was under the detection limit of the sensor.
In conclusion the project has successfully demonstrated the use of a novel fibre optic sensor in real conditions that can determine temperature and RH in good agreement with commercially used techniques.