Monitoring Ambient Air 2018

Developments in Air Quality
Current Issues and New Technologies

Conference with
Posters and Exhibition

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

Tuesday 11th & Wednesday 12th December 2018

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

Email: conf.aamg@gmail.com
Website: http://www.rsc.org

Monitoring Ambient Air 2018
Developments in Air Quality
Current Issues and New Technologies

Conference with Posters and Exhibition

Tuesday 11th and Wednesday 12th December 2018
The Royal Society of Chemistry, Burlington House, London

Day 1 - Tuesday 11th December

09:30 Registration

10:25 Welcome and Introductory Remarks

Session 1: Recently Published AQEG Reports

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

10:30 Effects of Vegetation on Urban Air Pollution. A report prepared by the UK Air Quality Expert Group
David Fowler, *AQEG, UK*

11:00 Discussion of report conclusions

11:20 Potential Air Quality Impacts of Shale Gas Extraction in the UK
Paul Monks, *AQEG, UK*

11:50 Discussion of report conclusions

12:10 Presentations by the exhibitors

12:40 **Lunch - exhibition & posters**

Session 2: Vehicle Exhaust Emissions and non-road mobile machinery (NRMM)

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

13:40 Vehicle emission insights from large data sets of remote sensing data
David Carslaw, *University of York, UK*

14:10 Mobile NO_2/NO_x measurements with the ICAD instrument to investigate air pollution distribution and personal exposure
Denis Pöhler, *University of Heidelberg, Germany*

14:40 Exposure to traffic-related air pollutants particle number and NO_2 when commuting by modes: walk,cycle, car and bus
James Tate, *University of Leeds, UK*

15:10 Tea / Coffee - Exhibition & Posters

15:40 Developing a new approach to the non-road mobile machinery inventory for London
Carl Desouza, *King's College London, UK*

16:10 London's low emission zone for non-road mobile-machinery
Stephen Inch, *Greater London Authority, UK*

16:40 The importance of particles and carbon dioxide in air pollution and in-vehicle human exposure
Nick Molden*, Emissions Analytics, UK*

Day 2 - Wednesday 12th December

09:30 Coffee and Exhibition

Session 3: Measurement Technologies

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

10:00 High Accuracy measurement of urban Nox pollution "hot spots"
Mark Peckham, *Cambustion Ltd, UK*

10:30 Generation of gases on demand for the calibration of ambient air monitors
David Green, *Air Monitors Ltd, UK*

11:00 Developments in greenhouse gas standards
Ruth Pearce, *National Physical Laboratory, UK*

11:30 Tea / Coffee - Exhibition & Posters

12:00 Measurement of formaldehyde pollution in ambient air
Arto Branders *Gasera Ltd, Finland*

12:30 Airborne microplastics
Stephanie Wright, *King's College London, UK*

13:00 Lunch - Exhibition & Posters

Session 4: Current Topics

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

14:00 Wildfires
Speaker to be confirmed

14:30 Combining global observations and models to monitor wildfire emissions and their impact on air quality
Mark Parrington, *ECMWF, UK*

15:00 Inland vessel emissions in China - an introduction to regulation and PEMS results
Xin Wang, *Beijing Institute of Technology, China*

15:30 Closing Remarks

15:35 Tea / Coffee - Close of Conference

ABSTRACTS

Effects of Vegetation on Urban Air Pollution. A report prepared by the UK Air Quality Expert Group

David Fowler
CEH Edinburgh

ABSTRACT

The effects of realistic planting schemes to alleviate air quality problems by enhancing deposition to the surface with vegetation in cities are small. Reductions in concentrations of PM_{10} for realistic planting schemes would be expected to be at the scale of a few percent. The work to date both from measurement and modelling shows that it is unlikely that large reductions in concentration (>20%) could be achieved using vegetation to enhance deposition over a substantial area.

For nitrogen dioxide (NO_2), vegetation is, generally speaking, of little benefit; it is not a very efficient sink. The deposition occurs in daytime, and primarily in the warmer months, when NO_2 is less of a problem. Vegetation is a very poor sink for nitric oxide (NO) and soil is a source of NO, at least partially offsetting any potential benefit of uptake by vegetation.

Locally (tens to hundreds of square metres) tree planting may enhance or reduce dispersion; this redistributes pollution but does not remove it. Where vegetation acts as a barrier close to a source, concentrations immediately behind the barrier owing to that source are reduced typically by a factor of about 2 relative to those which would occur without the barrier, whereas on the source side of the barrier concentrations are increased. Tree planting may also exacerbate the build-up of pollution within street canyons by reducing air-flow.

The use of trees to improve air quality is not without negative impacts as some tree species are important sources of biogenic volatile organic compounds (BVOCs), notably isoprene. BVOCs can enhance the formation of pollutants including PM and ozone. However, BVOC emissions could be avoided by selecting low emitting species. Similarly, the choice of plant species which are known sources of aeroallergens should be avoided.

Potential Air Quality Impacts of Shale Gas Extraction in the UK

Prof. Paul S. Monks on behalf of the Air Quality Expert Group
(https://uk-air.defra.gov.uk/library/aqeg/)

ABSTRACT

Recent exploratory studies have indicated that there are significant UK on-shore shale gas reserves which have the potential to be accessed by hydraulic fracturing (commonly known as “fracking”). The objective of the AQEG report was to review the available evidence base associated with air emissions from shale gas extraction activities, and draw conclusions regarding the potential for impacts on air quality in the UK. Recommendations have then been made with the aim of supporting policy makers, and ensuring that a suitably robust and comprehensive evidence base is available to support decisions.

However, the growth of shale gas operations in the UK is highly uncertain, depending on (but not exclusively) industry investment, regulation development, climate change, energy and economic policy and geological characteristics. Many of the conclusions are based on applying work from the US to the UK situation, which is very different in both in geology and proximity of extraction activities to people. As a result, recommendations below reflect the current lack of knowledge regarding on-shore shale gas extraction activities and its environmental impacts in the UK context.

The reports (https://uk-air.defra.gov.uk/library/reports.php?report_id=967) looks at the key areas of quantifying emissions, impacts at the national scale as well as impacts at the regional/local Scales.

The talk will review the reports main findings and explore the main recommendations in terms of

- Improving the Evidence Base Associated with UK Shale Resources and Reserves
- Improving the Projected Emission Estimates
- Evaluating Potential Impacts on the Local and National Scales
- Operational Monitoring at the Regional and Local Scales

Vehicle emission insights from large data sets of remote sensing data

David Carslaw
University of York and Ricardo

ABSTRACT

Developing a robust understanding of real-world vehicle emissions when they are affected by numerous factors such as technology, driving conditions and environmental factors such as ambient temperature is highly challenging. Vehicle emission remote sensing provides a compelling approach to address this issue by combining an approach that provides both real-world measurements and large sample sizes. This talk will summarise some of the wider issues that have not received as much attention through measurements from Ricardo and the University of York. These data sets now provide detailed information for over 300,000 vehicles under a wide range of conditions across the UK. Issues such as the effect of ambient temperature on emissions of NO_x will be explored and the deterioration effects of vehicle emission control systems that affect the emission of NO_2 will be highlighted. Many recent findings challenge current understanding, while providing a growing database for generating new insights and information of wider interest.

Mobile NO_2 / NO_x measurements with the ICAD instrument to investigate air pollution distribution and personal exposure

***Denis Pöhler*[1,2]**, Johannes Lampel[1,2], Martin Horbanski[1,2], Sven Riedner[1], Oliver Fischer[1], Katja Bigge[1], Ulrich Platt[1,2]

[1] – Institute of Environmental Physics, University of Heidelberg, Germany

[2] – Airyx GmbH, Germany

ABSTRACT

Nitrogen dioxide (NO_2) is currently the most critical air pollutant in Europe. The current measurements are based on few measurement locations with limited accuracy due to its indirect NO_2 measurement. For better quantification of air pollution and personal exposure there is a need for better, more accurate, mobile and in optimal case direct NO_2 measurements. We present the new ICAD (Iterative CAvity DOAS) NO_2 / NO_x instrument which combines the precise DOAS technology in an in-situ cavity instrument without the need for error prone NO_2 gas calibration. It measures directly NO_2 with high accuracy and NO_x with a NO to NO_2 converter. The small form factor, low power consumption and robust measurement principle allow easy mobile measurements to investigate hot-spots or simply to derive easy and precise NO_2 / NO_x concentrations at any location. We present results from several field and validation studies in Europe where mobile ICAD measurements are used to derive air pollution distributions in cities and estimate annual mean values from short term mobile investigations. Additional several studies on personal NO_2 exposure while driving a car, cycling, walking along a street or staying indoor will be shown. These are the relevant concentrations for health aspects and show under many circumstances much higher pollution levels than at measurement stations. Such investigations need to be put more into the focus of current discussions to lower the actual exposure to NO_2 air pollution. Several tested effective approaches are presented.

Exposure to the traffic-related air pollutants particle number and NO_2 when commuting by modes: Walk, Cycle, Car and Bus.

***James Tate*[1],** Marie Godward[1] and Duncan Mounsor[2]

[1] Institute for Transport Studies, University of Leeds, UK
[2] Enviro Technology Services Ltd.

ABSTRACT

We spend a significant proportion of our time travelling, often during weekday peak travel periods commuting to and from work or places of study. This travel coincides with peak concentrations of pollutants. The traffic-related air pollutants particle number (PN) and Nitrogen Dioxide (NO_2) are of interest as exposure has been found to both cause and exacerbate cardiovascular and respiratory conditions in all age groups.

This study simultaneously measured the exposure to PN using fast response (1Hz) portable condensation particle counters of commuters (walk, cycle, car, bus) travelling from the same residential location to the University of Leeds campus in the morning, and returning in the evening peak. All journeys started at the same time. The car (electric) was also equipped with fast response NO_2 analysers (CAPS) measuring in-cabin and ambient concentrations.

The cyclist consistently had the lowest cumulative exposure, in part due to its shorter journey time as they could pass queues using on-carriageway cycle lanes. Whilst the walking and cycling commuters were exposed to the highest short-term peaks in PN, they only resided in these polluted micro-environments for short periods. The highest concentrations of PN and NO_2 in the car cabin were observed in queuing traffic. An air exchange model applied to the car measurements, confirmed the un-impeded flow of NO_2 into the cabin. Only a strategy of sealing the cabin (re-circulation setting) when in queuing traffic could lower exposure. Levels of PN and NO_2 in the cabin were well correlated, confirming their categorisation as traffic-related air pollutants.

Developing a new approach to the non-road mobile machinery inventory for London

Carl D. Desouza, Daniel J. Marsh, Sean D. Beevers, and David C. Green

Environmental Research Group,
Department of Analytical Environmental and Forensic Sciences,
Faculty of Life Sciences and Medicine,
School of Population Health and Environmental Sciences,
King's College London

ABSTRACT

The 2013 London atmospheric emissions inventory attributes 7%, 11%, and 2% to NO_X, $PM_{2.5}$, and CO_2, respectively, NRMM in London. The current approach to developing the emissions inventory is based on a 'top-down' methodology, determined by UK fuel use and is distributed geographically using regional construction industry employment rates and is further refined by the location of planned construction in London. Emissions are calculated based on estimated NRMM fuel consumption, while activity data is determined from UK fleet composition data. There is substantial uncertainty in calculating exhaust emissions from NRMM in the current inventory, based on this methodology.

We have developed a new approach for London: a 'bottom-up' emissions inventory for the for non-road mobile machinery (NRMM) sector. Working with industry partners, we have combined measured real-world emission factors, with registered NRMM fleet composition as well as geographical location. To demonstrate this emissions inventory for policy development, the impact from two realistic policy scenarios were tested.

The current approach to the NRMM emissions inventory needs to be revised, due to the large uncertainties involved. The policy development possible using a robust and accurate bottom-up emissions inventory provides the opportunity to target emissions reduction actions for construction machinery, not only in London, but on a wider scale. This study quantifies the emission reductions achieved by implementing new emission abatement techniques and accelerating the uptake of cleaner machines could lead to a decrease in the tail-pipe emissions from the construction industry.

London’s Low Emission Zone for Non-Road Mobile Machinery

Stephen Inch MSc, BSc (Joint Hons), DIC
Greater London Authority

ABSTRACT

Non-Road Mobile Machinery (NRMM) is thought to be the third largest contributor to London’s overall NO_2 and PM_{10} emissions.

Progressive emissions standards for new machinery have led to improvements but, as machinery is often kept in service for many years, these do not lead to rapid emissions reductions in service.

In the absence of direct powers to force operators to use newer, less polluting equipment, London has developed a unique approach to regulating this sector, creating an NRMM Low Emission Zone through the Mayor’s planning powers.

This presentation will describe how, and where the Low Emission Zone operates in London; how it is enforced, and our proposals to progress the scheme towards zero emissions.

The limitations of the current Low Emission Zone will be explained and recommendations for how the sector may be more effectively regulated in future proposed.

The importance of particles and carbon dioxide in air pollution and in-vehicle human exposure

Nick Molden

Chief Executive Officer, Emissions Analytics Ltd

ABSTRACT

One of the consequences of Dieselgate has been falling sales of new diesel cars and the dominant trend is a switch back to gasoline cars. In the pursuit of reduced nitrogen oxide emissions, the unintended consequence may an increase in tailpipe particle and carbon dioxide emissions. Not only does this have an effect on air pollution and climate change, but the exposure of drivers to these pollutants may be particularly significant.

The latest data on tailpipe emissions of nitrogen oxides, particulates and carbon dioxide will be presented, including cars certified according to the new Real Driving Emissions regulation. The relative performance of diesel and gasoline vehicles will be shown. Furthermore, data from a new EQUA Index programme on in-cabin air quality will be presented, covering the rate of particle infiltration from a range of modern cars, and the propensity of carbon dioxide concentrations to rise when the air recirculation mode is activated.

High accuracy measurement of urban NOx pollution “hot spots”

Dr. Mark Peckham

Cambustion Ltd.

ABSTRACT

Fast response gas analyzers have been fitted to a variety of vehicles accurately to measure the transient emissions produced by real world driving. The results, when combined with RTK GPS data, provided the accurate position location of the resulting clouds of NOx produced by driving over speed bumps, traffic intersections and generally congested traffic. The results from a variety of petrol and diesel vehicles illustrated that urban driving produced spikes of NOx emissions often exceeding 1,000ppm but of duration much less than 1 second – too fast to be measured by conventional portable emissions measurement systems as used for the legislated emissions testing. Combining this high temporal resolution concentration data with GPS provided maps of urban pollution hot spots with an accuracy of 14cm at 30mph. The effects of urban driving on in-service buses were also studied with particular attention to typical manoeuvers such as approaching and departing from bus stops; a large spike of NOx being emitted at pull-away.

Generation of Gases on Demand for the Calibration of Ambient Air Monitors

David Green
Air Monitors Limited.

ABSTRACT

Monitoring ambient levels of NO, NO_2 and O_3 is a basic requirement of any air quality network and the calibration of the gas monitors used has traditionally been accomplished by the manual or automated injection of compressed cylinder gases. These gases can be cumbersome to transport and handle, unstable over long periods, expensive and are only able to challenge the monitors at one fixed concentration.

This presentation will discuss a new gas generation technique which is able to convert N_2O by photolysis to NO from small inexpensive cartridges. (normally used in the food industry) The NO produced can subsequently be converted by gas phase titration with O_3 to NO_2. By the introduction of a zero air scrubbing system concentrations of all three gases can be generated on demand from 20ppb to 1000ppb by dilution with zero-air.

This technology would enable multi point calibrations to be conducted locally or remotely with improved accuracy, stability and repeatability. The system can also be programmed to schedule calibrations according to a pre-programmed sequence. The technology also dispenses with cylinder deliveries, handling, cylinder rentals, purchase and maintenance of regulators and much of the manual labour associated with conventional calibration methods.

Gas Primary Reference Material

***Ruth E. Hill-Pearce**,* Eric B. Mussell Webber, David R. Worton, Paul J. Brewer

National Physical Laboratory

ABSTRACT

National Metrology Institutes (NMIs) produce gas Primary Reference Materials (PRMs) with the lowest achievable uncertainties. They are at the top of the traceability chain and are used by a variety of stakeholders for measurements where low uncertainty in the amount fraction of a gas is paramount, for example where compliance with legislation must be demonstrated. This talk aims to examine the causes of uncertainties in PRM amount fraction and the techniques available to reduce these uncertainties. To illustrate the challenges involved, an example of a research project towards reducing the uncertainties in greenhouse gas reference standards with the aim of meeting the data quality objectives set by the World Meteorological Organisation (WMO) will be presented.

Measurement of Formaldehyde pollution in ambient air

Arto Branders, Ismo Kauppinen, Tuomas Hieta

Gasera Ltd, Finland

ABSTRACT

Formaldehyde is commonly used chemical compound that exists in various forms and at room temperature, is a colorless, distinctive, strong and even pungent smelling, flammable and gaseous substance. Formaldehyde is an ozone precursor and classified as carcinogenic compound. It is highly injurious to health, but until today, it has been very difficult to measure. Levels above 0.1 ppm can cause acute health problems. It is commonly used chemical compound that is manufactured for use on an industrial scale. Formaldehyde is used e.g. for manufacturing of building materials, wood products and furniture. Formaldehyde in indoor air is thus caused by emissions from wood products. Formaldehyde in outdoor air again, is largely a result of photochemical processes and the use of biofuels.

Formaldehyde is monitored both in indoor and outdoor air and the regulation and recommendations for monitoring are constantly increasing. For ambient air, pollution monitoring is regulated and for indoor, measurement is done for occupational safety. That is, ambient air concentration limits have to be stricter as people are constantly exposed whereas in indoor air people are allowed for short time exposures if they are considered healthy persons.

We address the trace formaldehyde measurement need with widely tunable quantum cascade laser based photoacoustic detection[1,2]. Ultimately sub-ppb level detection limits are demonstrated which proves high suitability for continuous Formaldehyde monitoring of ambient fugitive emissions.

[1] T. Kuusela, J. Kauppinen. Appl. Spectrosc. Rev., 42, (2007)

[2] C. B. Hirschmann, J. Lehtinen, J. Uotila, S. Ojala, R. L. Keiski, Appl. Phys. B (2013)

Airborne Microplastics

Dr Stephanie Wright, Mr Joseph Levermore, Mr Jannis Ulke, Prof Frank Kelly

MRC-PHE Centre for Environment and Health, Department of Analytical, Environmental & Forensic Sciences, School of Population Health & Environmental Sciences, King's College London

ABSTRACT

Microscopic plastic particles – microplastics – are a global issue for aquatic habitats. Recently, they have been reported in atmospheric deposition, and indoor and outdoor air, raising concern for public health due to the potential for exposure via inhalation. However, very little is known about airborne microplastics, including their spatial and temporal concentrations; chemical composition; and, importantly, whether they occur in the inhalable size range. Here we present preliminary data on the presence of microplastics (>25 µm) in total atmospheric deposition sampled over one month at an urban background site in London, UK. Using Nile Red staining, bright field and fluorescence microscopy and Fourier-transform Infrared spectroscopy, ten times more fibrous microplastics were found than non-fibrous. This equated to an average deposition rate of 706 fibrous microplastics/m^2/d, with polyacrylonitrile being the predominant polymer type. We also present developments for an analytical protocol compatible with Raman microscopy and an active pollen sampler, which has been validated to detect microplastics down to 2 µm in mock samples, and 2.5 µm in environmental particulate matter (PM). As global pressure to reduce road transport and fuel burning emissions increases, PM composition is likely to shift. In combination with a predicted increase in plastic use, especially in the textile sector (4%/year), the proportional concentration of airborne microplastics will become increasingly important. It is therefore timely to establish baseline knowledge of global airborne microplastic burdens and begin to understand what their potential role in PM-associated health effects might be.

Wildfires

Speaker to be Confirmed

ABSTRACT

Combining global observations and models to monitor wildfire emissions and their impact on air quality

Mark Parrington

European Centre for Medium-Range Weather Forecasts

ABSTRACT

Wildfires are a significant component of the Earth system, emitting large quantities of trace gases and aerosols, which perturb the chemical composition of the atmosphere and can have impacts on surface air quality far from the emission source. The Copernicus Atmosphere Monitoring Service (CAMS), implemented by ECMWF on behalf of the European Commission, provides a unique perspective on the transport and impact of atmospheric pollution associated with wildfire emissions, using near-real-time satellite observations of wildfire locations and emissions of aerosols and trace gases. Five-day forecasts of global air quality, operationally produced twice a day at 0 UTC and 12 UTC at a spatial resolution of approximately 40 km, are initialized from analyses which assimilate the latest satellite observations in a state-of-the-art global model. Regional air quality forecasts for Europe in CAMS utilize a suite of regional models which take lateral boundary conditions from the global system. In addition to this, CAMS produces global reanalyses, providing consistent multi-year (2003 to present) datasets of global atmospheric composition and air quality. This presentation will use examples of acute wildfire cases in the last 12 months (from Siberia, Sweden and the UK) to highlight how CAMS products work in real situations for monitoring and evaluating global wildfire emissions in relation to atmospheric composition and air quality.

Inland vessel emissions in China
- an introduction to regulation and PEMS results

Xin Wang
Beijing Institute of Technology

ABSTRACT

This presentation briefly reviews the domestic regulations on vessel emission control in China, and, from methodology to results, summarizes the PEMS-based inland vessel emissions measurement done by Beijing Institute of Technology and Vehicle Emission Control Center, Ministry of Ecology and Environment. Unlike ocean-going vessels, inland vessels are small in size, old in engine technology but high in population and activity. In China, vessel emissions, primarily from the inland sector, has been recognized as one of the predominant contributors to national non-road emission inventory.

Typical operating conditions of inland vessels only comprise arrival, cruise, and departure. Concentration peaks of CO, HC, and PM emissions were found mainly during arrival and departure maneuvering due to the highly transient operations within these periods. NOx emissions were also high during maneuvering and maintained at a considerately high level in cruise condition. High concentrations of particle number emission with Dp smaller than 0.1 micron were noticed in maneuvering conditions, which could be a contributor to fine particle contamination of surrounding cities. Compared to downstream cruise, upstream cruise could give much larger emission factors, and PM emission was in particular sensitive to the direction of water flow. On a ton-kilometer basis, emission factors of CO, HC, and NOx for an average inland vessel are about 1 to 3 times higher than those for a China-III certified bus. However, such a difference could be as high as 17 to 47 times in terms of PM emission.

POSTER ABSTRACTS

Systematic Evaluation of Condensation Particle Counters

Krzysztof Ciupek, Paul Quincey, Jordan Tompkins

National Physical Laboratory, Hampton Road, Teddington, TW11 0LW, United Kingdom

POSTER ABSTRACT

Condensation Particle Counters (CPCs) are widely used to measure aerosol particle number concentration and, when combined with a size-selection device, to determine their size distribution. When calibrating these instruments, two main properties are being tested: the linearity of the measurement response with concentration, and the particle detection efficiency at different particle sizes. The first feature provides one or more calibration factors to improve the accuracy of the CPC's results over a concentration range (concentration dependence) whereas the latter shows the instrument's size dependence. Determinations of both properties are usually provided by the manufacturer, however, their values depend on the particle material and might change over a period of using the instrument. Additionally, the values may be stated for each model, but they might be different for each particular instrument, and this will have direct impact on the quality of the measurements. In this study, a comparison of three CPC models is shown with the focus on their linearity. The results are juxtaposed with the manufacturer's specification, showing limitations in the use of such instruments and how their properties might vary among the same type of instruments. Each CPC was calibrated in the National Physical Laboratory (NPL) the UK's National Measurement Institute (NMI). The NPL airborne nanoparticle metrology laboratory maintains a UKAS accredited facility to ISO 17025, for the calibration of such instruments. The results of this study has been compared with the criteria that CPC instrument have to fulfil in accordance with the requirements given by the ISO 27891:2015 standard.

Developing a new chemical link among abundance, composition and sources of black carbon in an urban environment

***Melissa Nikkhah-Eshghi*[1,2]**, Philippa Ascough[1], Jaime L. Toney[2], Mathew Heal[3], Jim Mills[4]

[1] Scottish Universities Environmental Research Centre, Rankine Avenue, East Kilbride, G75 0QF, UK
[2] School of Geographical and Earth Science, University of Glasgow, Glasgow G12 8QQ, UK
[3] School of Chemistry, University of Edinburgh, Joseph Black Building, David Brewster Road, Edinburgh, UK, EH9 3FJ
[4] Air Monitors, 2/3 Miller Court, Severn Drive, Tewkesbury, UK, GL20 8DN

POSTER ABSTRACT

Black carbon (BC) is both a poorly characterised and understood air pollutant, which has highly detrimental effects on both the environment and human health, despite being the second strongest anthropogenic radiative forcing component in the atmosphere. BC has a short atmospheric lifetime, which means there would be great benefits in reducing its concentrations, as highlighted in the 2018 IPCC special report "Global Warming of 1.5 °C". In Glasgow, a low emission zone (LEZ) will be implemented on 31/12/18, with the aim of improving air quality. This provides an opportunity to assess the impact of mitigation measures on BC concentrations and composition.

Using a microAethalometer, data was collected across Glasgow city centre, before the LEZ was introduced. A regular route was used during the sampling period, which included 5-minute stops at sample sites. These data will be compared with repeat measurements after the LEZ is in place, to provide a comparison of BC concentrations and composition before and after the LEZ.

The project aim is to characterise the spatiotemporal abundance of BC in Glasgow, and to identify its chemical structure and precursors, and how these vary. This will be achieved through techniques including hydropyrolysis, gas chromatography-mass spectrometry and radiocarbon dating, to provide insights to potential health impacts of BC from different sources. The work will highlight the areas in Glasgow that policy makers need to focus on with regards to mitigation strategies, taking social factors into account such as population density and social activity.

Evaluating the Sensitivity of Fine Nitrate Aerosol Production to Changing Ammonia Emissions in the UK

V. B. Bright, L. S. Neal, P. Agnew, C. Hardacre, and N. H. Savage

Met Office, Exeter, UK

POSTER ABSTRACT

Atmospheric composition on the regional scale directly effects air quality and in turn has significant implications for human health. Particulate matter (PM) can have a significant effect on health, especially in the fine fraction $PM_{2.5}$. It is therefore necessary to examine the sources of such atmospheric constituents and investigate the processes that lead to the degradation of air quality in order to develop effective policy mechanisms to reduce exposure.

While road traffic emissions of particulate matter are well known, additional, more complex, sources such as those from agriculture are important during some air pollution episodes and make a significant contribution to particulate levels in the UK and Europe. Ammonia (NH_3) is a precursor gas that can react in the atmosphere and increase aerosol levels through the formation of ammonium nitrate aerosol (NH_4NO_3) - an important component of $PM_{2.5}$.

It is of interest to investigate the sensitivity of aerosol predictions to variations in ammonia emissions for two reasons: (i) to estimate the impact of possible errors in emissions inventories and (ii) to give some indication of the likely impact of future ammonia emissions changes on particulate levels. Using the UK Met Office's Air Quality configuration of the Unified Model (AQUM) (Savage et al. 2013), we have studied the sensitivity by varying the ammonia emissions and monitoring the impact on predicted ammonium nitrate aerosol air concentrations close to the surface. Initial results suggest that, in general, the sensitivity is small, suggesting that ammonium nitrate aerosol production is limited by other factors.

Tree shelter belts for ammonia mitigation: A new tool for planning

Bill Bealey[1], Elena Vanguelova[2], Gail Atkinson[2], Mike Perks[2], Stephen Bathgate[2], ***Christine Braban[1],*** Tom Locatelli[2], David Leaver[1] and Cristina Martin Hernandez[1]

[1]Centre for Ecology and Hydrology, Edinburgh,
[2]Forest Research - Alice Holt & Northern Research Station

POSTER ABSTRACT

Approximately 90% of UK emissions of ammonia come from livestock housing, animal manures and inorganic fertilisers. Trees can be particularly effective scavengers of air pollutants due to their effect on turbulence (Beckett et al. 2000, Nowak 2000) that promotes dry deposition to the tree surface and increased dispersion. Previous research (Bealey et al. 2014) has shown that carefully planned and implemented approaches to using tree shelterbelts for ammonia mitigation can lead to a significant decrease in NH3 concentrations downwind from sources.

Planning of livestock units often require tree planting schemes for visual screening of buildings, and famers are also turning to more free-range systems for livestock (in particular poultry) which can be enhanced with tree planting for cover and extended ranging. Current work funded by SEPA, and undertaken by CEH and Forest Research, has produced guidance and an online tree-belt design tool to maximise these benefits together with ammonia recapture. Users need guidance on elements like orientation, planting distances, species selections, spacing and design to optimise these multi-benefits. The use of a simple tool to assess potential mitigation effects relevant for the site proposed could significantly widen the use of this approach by the farming community.

Development of a tool to provide near real-time UKEAP EMEP gas and aerosol composition data from Auchencorth Moss

Marsailidh Twigg, ***Christine Braban,*** David Leaver

Centre for Ecology and Hydrology, Edinburgh

POSTER ABSTRACT

At Auchencorth Moss and Chilbolton rural air quality supersites the on-line ion chromatography-based instruments, Measurement of AeRosols and Reactive GAses, MARGA, have been measuring the hourly composition of gas and inorganic aerosol for 10 years. Though data is provided by UK-Air on an annual ratified basis, development is being undertaken to develop a tool for providing data nearer to real time for air quality information stakeholders to be able to visualise and use the data operationally. In this poster an outline of the work is presented and future plans discussed.

Pollution Exposure Monitoring in the Homes of Patients with Sleep Disordered Breathing in Glasgow Urban Areas: Feasibility and Initial Observations

***F Sutherland*[1],** G McDowell[2], T K Beattie[1], A Hastings[1], C Carlin[2], I J Beverland[1]

[1]Department of Engineering, University of Strathclyde
[2]Queen Elizabeth University Hospital, NHS Greater Glasgow and Clyde

POSTER ABSTRACT

The association between air pollution and sleep-disordered breathing (SDB) is poorly understood. Exposure to PM_{10} and $PM_{2.5}$ in urban areas are associated with SDB in research in the USA and Taiwan. However, exposure estimation in these studies is based on outdoor measurements and does not include exposure measurements that may be more closely related to people's personal exposure. We have developed a personal home monitoring kit to quantify indoor exposure to pollutants ($PM_{2.5}$ and NO_2 concentrations) and SDB treatment efficacy in patients living in urban areas. The kit measured 1-min average $PM_{2.5}$ concentrations using a nephelometer (MicroPEM), and integrated deployment period measurements of black carbon (estimated from filter darkness) and NO_2 (duplicate passive diffusion tubes attached to enclosure containing MicroPEM). Fifteen participants took the kit home and placed it in their bedroom for sampling periods of 7-10 day duration. Patients' heart-rate variability was measured using multi-day actigraphy. We observed substantial variation in indoor $PM_{2.5}$ pollution metrics (mean, peak and temporal exposure patterns); with peak indoor $PM_{2.5}$ exceeding the WHO recommended 24 h guideline (25 µg/m^3) in several subjects. Exposure peaks were associated with traffic-related 'rush hour' times. Changes in heart rate variability were temporally associated with short-term increases in in $PM_{2.5}$. We are continuing to investigate temporal associations between the physiological and air monitoring data.

Low-cost Network for sensing Ammonia from Agricultural Activities

***Matias Insausti*[1],** Qiang Ni[2], Mariana Rufino[2]

[1]Universidad Nacional del Sur, Bahía Blanca. Argentina.

[2]Lancaster University, Lancaster. UK.

POSTER ABSTRACT

The mitigation of ammonia emissions is one of the current largest challenges for several environmental agencies around the world. About 88% of ammonia in the atmosphere comes from agricultural sources. The importance of reduction these nitrogen (N) losses is not just to contribute to preserve the environment, but to improve N resources utilization and also avoiding unnecessary costs. In order to adopt ammonia mitigation methods, new developments on sensing tools are required. There is a need for sensitive, selective, robust and user-friendly sensors to monitor livestock production and fertilization techniques.

It was used a low-cost photometric sensor to register the colour intensity change directly related to ammonia concentration in air. The derivatization reaction used was the well-established Berthelot's reaction. The device use a small portion of paper per sample, allowing scheduled automated measurements. The telemetry was achieved by connecting sensors using LoRa™ wireless technology. The amount of ammonia measured in air was in the range between 0.01 to 10 ppm_v. LoRa communication enables data collection from a wide-area with a very low power consumption.

The developed method is sensitive enough to measure ammonia losses in fertilization process and robust enough to be used in livestock facilities. The agricultural need of large amount of sensor deployment was achieved thanks to the mixture of low-cost and battery powered electronics and the selective colour reaction.

Source Profiling of Port and Ship-Related Particulate Matter

Natasha H. C. Easton[1], Matthew J. Cooper[1], P. Sargent Bray[1], Florentin Bulot[2], Simon J. Cox[2], Steven J. Johnston[2], Gavin L. Foster[1] and Matthew Loxham[3]

[1] Faculty of Environmental and Life Sciences, University of Southampton
[2] Faculty of Engineering and Physical Sciences, University of Southampton
[3] Faculty of Medicine, University of Southampton

POSTER ABSTRACT

Southampton regularly breaches World Health Organisation (WHO) air quality guidelines for background particulate matter (PM) concentrations, particularly for $PM_{2.5}$. PM has detrimental effects on health, especially upon respiratory and cardiovascular systems. Local initiatives to reduce air pollution have thus far focussed on road vehicle emissions. However, Southampton is also home to a large port, with both cruise and cargo ships and associated shore-side activities. The composition of PM emissions from various port activities is poorly understood and is of paramount importance in understanding source contributions.

A high volume cascade impactor was used to collect coarse (median aerodynamic diameter 10-2.5 µm), fine (2.5-0.1 µm) and ultrafine (<0.1 µm) fractions of PM at six sites across Southampton Docks. Sites were chosen on the basis of specific local PM-generating activities, to selectively collect material more indicative of the different types of ship and dock related pollution. PM elemental and ionic concentrations were determined by inductively coupled plasma mass spectrometry and ion chromatography respectively.

PM composition was shown to vary across sampling sites and size fractions. Enrichment of shipping tracers (V:Ni ratio 2.5-4.0) was found within the fine and ultrafine fractions *vs.* coarse, and in the cruise ship season *vs.* outside. Conversely, coarse PM was generally shown to be dominated by sea spray and crustal materials. Elemental analyses showed good evidence of localised sources of PM within the port. Through extensive characterisation of PM composition, this study is the essential first step in enabling a full source apportionment model to be developed for Southampton.

Professional Drivers Exposure to Black Carbon in London, the Diesel Exposure Mitigation Study (DEMiSt).

***Lim, Shanon*[1],** Barratt, Benjamin[1], Holliday, Lois[2] and Mudway, Ian[1]

[1]Environmental Research Group, King's College London. [2]Centre for Primary Care and Public Health, Queen Mary University of London.

POSTER ABSTRACT

Background: Minimal research has been undertaken to quantify the exposures of professional drivers to diesel exhaust fumes. The aim of DEMiSt is to characterise exposures for professional drivers under a range of occupational settings, vehicle types and driving conditions and to identify and evaluate low-cost intervention methods to reduce drivers' exposures.

Method: The latest generation of personal GPS-linked black carbon sensors are being provided to 200 drivers, working within London's M25. Each driver is monitored for 96 continuous hours at one-minute resolution. The drivers are also asked to complete a questionnaire, detailing their vehicle ventilation preferences, vehicle type and the number of hours they drive during the day.

Preliminary Results: Preliminary results from the first 90 participants indicate a mix of long elevated periods of black carbon, with short extremely high spikes occurring periodically throughout the working day. The results show that the drivers' exposure is over three times higher at work (mean = 4.0 µg/m^3, range =1.0 – 25.1 µg/m^3) compared to times at home (1.3 µg/m^3, 0.4 – 4.2 µg/m^3). The highest exposed drivers were taxi drivers (6.9 µg/m^3) while the lowest were ambulance staff (2.2 µg/m^3), hypothesised due to their ability to bypass congestion in emergency situations.

Conclusion: The preliminary results of the study show that there are practical steps which can reduce exposure to drivers. Ventilation settings, route choice and type of vehicle all appear to influence driver exposure. Further evaluation of exposure mitigation measures will lead to robust evidence and provide recommendations to companies to reduce occupational exposures of their drivers.

Comparison of the field performances of multiple low-cost particulate matter sensors in an urban area

***Florentin M. J. Bulot*[1],** Steven J. Johnston[1], Philip P. J. Basford[1], Natasha H. C. Easton[2], Simon J. Cox[1], Gavin L. Foster[2], Andrew K. R. Morris[3], Matthew Loxham[4]

[1]Faculty of Engineering and Physical Sciences, University of Southampton,
[2]Faculty of Environmental and Life Sciences, University of Southampton,
[3]National Oceanography Centre, Southampton, UK
[4]Faculty of Medicine, University of Southampton, Southampton, UK

POSTER ABSTRACT

Introduction: Exposure to particulate matter (PM) is one of the leading causes of morbidity and mortality worldwide. Understanding personal exposure requires higher spatial resolution than provided by a small number of reference stations. “Low-cost” PM sensors may provide an opportunity to improve spatial resolution of PM monitoring, but there are uncertainties regarding the reliability of their data. The aim of this work was to characterise the in-field performance of four models of low-cost PM sensor.

Methods: Six air quality monitoring boxes, each containing one of each of four models of PM sensor (Plantower PMS5003, Plantower PMS7003, Alphasense OPC-N2 and Honeywell HPMA115S0), and temperature and relative humidity sensors, were installed at three locations at each of two schools in Southampton between February and September 2018. Sensor performance was assessed by comparing reported PM concentrations (1Hz, n=500,000 readings per individual sensor) between sensors within the same box, across sites, and with a background reference station. Effects of PM concentration and meteorological factors on sensor performance are discussed.

Results: $PM_{10}/PM_{2.5}$ correlation varied between sensor models, suggesting different methods of determination. Agreement of sensor readings with background reference concentrations varied with levels of background pollution, relative humidity, months and wind direction.

Conclusions: We have observed substantial variation between models of sensors and suitable agreement between the sensors but also with the reference station. Improved understanding of factors influencing sensor performance will inform interpretation of data from deployment of further monitors as part of a forthcoming city-wide PM-monitoring network