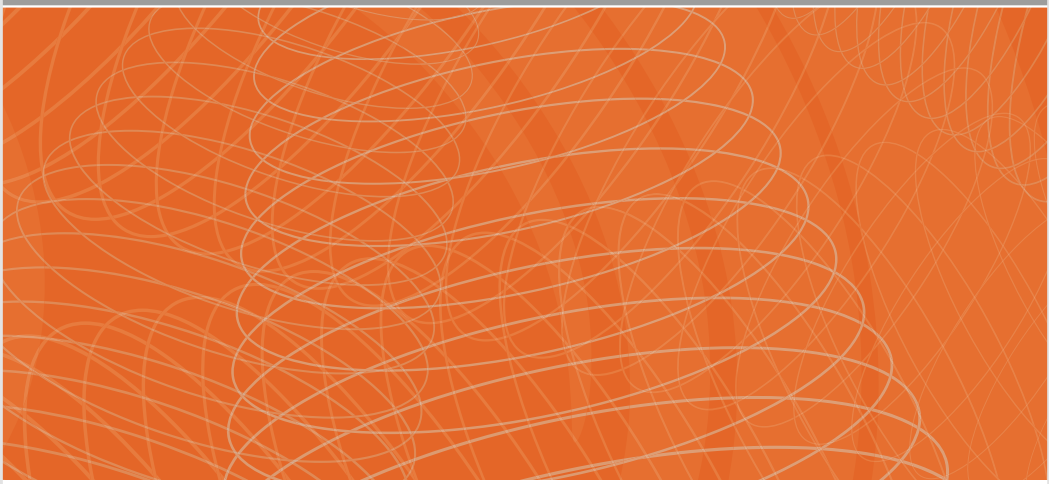
Karlsruhe Institute of Technology

European Federation of Clean Air and Environmental Protection Associations (EFCA) International Symposium

Ultrafine Particles – Air Quality and Climate

Brussels, Belgium
May 04 and 05, 2015

BOOK OF ABSTRACTS AND PROGRAM



EFCA

KIT – University of the State of Baden-Wuerttemberg and
National Research Center of the Helmholtz Association

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Venue

Representation of the State of
Baden-Württemberg to the EU
Rue Belliard 60-62
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URN: urn:nbn:de:swb:90-470091

DOI: 10.5445/IR/1000047009

European Federation of Clean Air and Environmental Protection Associations (EFCA) International Symposium

Ultrafine Particles – Air Quality and Climate

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INTRODUCTION

Ultrafine particles, (UFP), are the smallest constituents of airborne particulate matter and are considered to be causing serious health problems and environmental effects. They may nucleate as a result of combustion processes or result from photochemical reactions of volatile precursor gases, thus showing a clear link to gaseous pollution. Recently, direct emission of man-made nanoparticles, e. g. from the incineration or degradation of synthetic nanomaterials, has attracted considerable attention. Apart from the specific role of UFP in air quality, they play also a key role in atmospheric processes such as cloud formation and precipitation and, in fact, in climate. The relation between UFP and human health and that of UFP and climate are both areas of active research and cross-links between these fields are found nowadays. The new subtitle of the conference series: "**air quality and climate**" reflects this development.

Present policies to decrease exposure to particulate matter make use of the mass-based metrics PM10/PM2.5, which do not properly represent all risks for human health. EFCA is, therefore, in favour of the development of a fraction-by-fraction approach, both with respect to size and chemical composition. It already recommended European policymakers the introduction of Black Carbon Particles as additional metric in the Air Quality Directive.

The organizers trust that EFCA's 5th Ultrafine Particles Symposium 2015 will again feature the most recent scientific progress in the field and so contribute to policy-relevant developments and thus improve the dialogue with policymakers in Europe. The Symposium has gained visibility by permanently moving to Brussels and attracts an effective mix of EU representatives and scientists. EFCA and KIT, together with GUS and CEEES are pleased to organize this event again. We cordially invite all experts for active contributions and hope to see you again at the State representation of Baden-Württemberg in Brussels in May 2015.

Thomas Leisner | Chairman

Monday, 4 May

Opening

10:30 EFCA President, Symposium Chairman,
Representative of the State of Baden-Württemberg

Keynotes – Session A

11:00 – 12:30 | Europasaal
Session Chair: Thomas Leisner

11:00 A.1
Health effects of Ultrafine Particles – New evidence from epidemiological studies
Annette Peters
Helmholtz Zentrum München, Germany

11:45 A.2
Nucleation of ultrafine particles in the atmosphere
Markku Kulmala
University of Helsinki, Finland

12:30 Lunch

Session B – Measurement, Chemistry and Modelling 1

13:45 – 15:25 | Europasaal
Session Chair: Thomas Reichert

13:45 B.1
Black carbon, total and size-resolved particle number concentrations in urban areas near Schiphol airport (The Netherlands)
Menno Keuken
TNO, Utrecht, the Netherlands

14:10 B.2
Modelling ultrafine particles concentrations at a street-level scale
Hans Hooyberrghs
VITO, Mol, Belgium

14:35 B.3
Highly resolved ultrafine particle number concentration maps for the city of Zurich, Switzerland
Michael Müller
Empa, Dübendorf, Switzerland

15:00 B.4
Atmospheric composition measurements for improving the high resolution modelling of the Brussels urban atmosphere
Alexander Mangold
Royal Meteorological Institute of Belgium,
Brussels, Belgium

Session C – Health effects

13:45 – 15:25 | Stuttgart/Karlsruhe
Session Chair: Vladimira Vadjic

13:45 C.1
Alveolar epithelial cells initiate nanoparticle-induced acute lung inflammation
Tobias Stöger
Helmholtz Zentrum München, Germany

14:10 C.2
Automated exposure station for the air-liquid interface exposure of human lung cell cultures towards aerosols
Sonja Mülhopt
Karlsruhe Institute of Technology, Karlsruhe, Germany

14:35 C.3
Day-to-day variability of toxic events induced by organic compounds bound to size segregated atmospheric aerosol
Jan Topinka
Institute of Experimental Medicine AS CR, Prague, Czech Republic

15:25 Coffee Break

Session D – Sources and Mitigation of Emissions

15:45 – 17:25 | Europasaal
Session Chair: Gordana Prehnic

15:45 D.1
An estimation of the marine sources impact on PM_{10} levels in Northern France
Cloé Roche
Université du Littoral Côte d'Opale (ULCO),
Dunkerque, France

16:10 D.2
Ultra-low emission wood combustion by seamless adaptation of an electrostatic precipitator to a modern grate boiler
Hanns-Rudolf Paur
Karlsruhe Institute of Technology, Karlsruhe, Germany

16:35 D.3
On the status of discussion within the International Maritime Organization about the consideration of the impact on the arctic of emissions of black carbon from international shipping
Peter Lauer
MAN Diesel & Turbo SE, Augsburg, Germany

17:00 D.4
Nanoparticle emissions from thermal desorption/regenerative oxidation of contaminated soils
Senem Ozgen
Politecnico di Milano, Milano, Italy

Session E – Measurement, Chemistry and Modelling 2

15:45 – 17:25 | Stuttgart/Karlsruhe
Session Chair: Harald Saathoff

15:45 E.1
Investigating the chemical composition of sub-100 nm particles with chemical ionization mass spectrometry
Claudia Mohr
Karlsruhe Institute of Technology, Karlsruhe, Germany

16:10 E.2
Frequency of new particle formation events in high insolation urban environments
Xavier Querol
Institute of Environmental Assessment and Water Reaearch (IDAEA), Barcelona, Spain

16:35 E.3
Role of fine and ultrafine particles in the formation of haze in Beijing, China
Klaus Schäfer
Karlsruhe Institute of Technology, Karlsruhe, Germany

17:00 E.4
BC monitoring as a proxy of the UFP concentration
Sébastien Fays
ISSeP, Liége, Belgium

Session F – Posters & Buffet

17:30 – 19:00 | Foyer/Patio

F.1 **Comparison between ultrafine and fine particulate matter: chemical characterization and in vitro toxicity in human bronchial epithelial cells BEAS-2B**
Frédéric Ledoux
Université du Littoral Côte d'Opale (UCEIV),
Dunkerque, France

F.2 **Measurement of ultrafine particles from small non-road engines under real-world operating conditions**
Michal Vojtíšek-Lom
Technical University, Prague, Czech Republik

F.3 **Water-soluble ions in $PM_{2.5}$ particle fraction in Zagreb Air, Croatia**
Mirjana Cackovic
Institute for Medical Research and Occupational Health, Zagreb, Croatia

F.4 **Sources and distribution of ultrafine atmospheric aerosol measured in the city of Leicester (UK)**
Sarkawt Hama
University of Leicester, Leicester, United Kingdom

Session F – Posters & Buffet

17:30 – 19:00 | Foyer/Patio

F.5 **Evaluation of the impact of sulfur poisoning on catalytic stripper technology**
Jacob Swanson
Catalytic Instruments GmbH & Co. KG, Rosenheim, Germany

F.6 **WMA statement on the prevention of air pollution due to vehicle emissions**
Manfred Neuberger
Medical University of Vienna, Austria

F.7 **Measuring 1-3 nm particles in urban air**
Joonas Vanhanen
Airmodus Ltd., Helsinki, Finland

F.8 **Health adverse effects within the population neighboring a landfill: Cd and Pb impregnation, oxidative stress and nephrotoxicity**
Dominique Courcot
Université du Littoral Côte d'Opale (UCEIV),
Dunkerque, France

F.9 **The effect of a thermal denuder on the measurement of black carbon generated in a diesel engine**
Jeonghoon Lee
School of Mechanical Engineering, KOREATECH, Cheonan, South Korea

Tuesday, 5 May

Keynotes – Session G

09:00 – 10:30 | Europasaal
Session Chair: Thomas Leisner

09:00 G.1
Ultrafine particles in the urban atmosphere
Roy Harrison
University of Birmingham, United Kingdom

09:45 G.2
Dramatic increase projected in mortality attributable to fine particulate air pollution
Jos Lelieveld
Max Planck Institute for Chemistry, Mainz, Germany

10:30 Coffee Break

Session H – Measurement Methods

10:45 – 12:25 | Europasaal
Session Chair: Karl-Friedrich Ziegahn

10:45 H.1
Release of engineered nanoparticles during waste incineration
Inge-Maria Lang
Karlsruhe Institute of Technology, Karlsruhe, Germany

11:10 H.2
A new portable device for high time resolved measurements of wide range aerosol size distributions
Hans-Jürgen Grimm
Grimm Aerosol Technik, Ainring, Germany

11:35 H.3
Portable nanoparticle instrumentation for oncoming motor vehicle regulations
Luis Cachòn
Testo AG, Titisee-Neustadt, Germany

12:00 H.4
Determination of the filtering effect of airborne particles for a model of flow around a cylinder with a slit
Dorota Kaminska
Kamika Instruments, Warszawa, Poland

Session I – Monitoring and Exposure 1

10:45 – 12:25 | Stuttgart/Karlsruhe
Session Chair: Guiseppe Fumarola

10:45 I.1
Characterisation of exposure to ultrafine particles at traffic intersections
Prashant Kumar
University of Surrey, Guildford, United Kingdom

11:10 I.2
Personal exposure to ultrafine particles, Black Carbon and $PM_{2.5}$ in different microenvironments
Jianwei Gu
University of Augsburg, Augsburg, Germany

11:35 I.3
The Measurement of Ultrafines & Black Carbon in Glasgow City Centre
David Sykes
Ricardo-AEA, Glasgow, United Kingdom

12:00 I.4
Ultrafine particles and black carbon exposure concentration levels along a pedestrian route
Giovanni Lonati
Politecnico di Milano, Italy

12:25 Lunch

Session J – Monitoring and Exposure 2

13:25 – 15:05 | Europasaal
Session Chair: John Murlis

13:25 J.1
Monitoring of UFP concentration and size distribution at four urban background sites in NW-Europe
Jeroen Staelens
Flemish Environment Agency (VMM), Antwerpen, Belgium

13:50 J.2
Near one km vertical profiles of ultrafine particles over the city of Barcelona, Spain
Xavier Querol
Institute of Environmental Assessment and Water Research (IDAEA), Barcelona, Spain

14:15 J.3
Ultrafine particle and black carbon measurements at an urban background site: a multi-technique monitoring approach
Giovanni Lonati
Politecnico di Milano, Italy

14:40 J.4
Monitoring black carbon concentrations with mobile devices in the city of Liège
Luc Bertrand
ISSeP, Liege Belgium

Concluding discussion

15:05 – 15:45

Symposium Chairman

Thomas Leisner
Institute for Meteorology and Climate Research,
Karlsruhe Institute of Technology, KIT, Germany

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Proceedings

Presentations and Posters will be published electronically after the Symposium.

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Health Effects of Ulftrafine Particles – New Evidence from Epidemiological Studies

Annette Peters
Director of the Institute of Epidemiology II, Helmholtz Zentrum München, Neuherberg, Germany
Harvard School of Public Health, Department of Environmental Health, Boston, MA, USA

ABSTRACT

The presentation will address the impact of ultrafine particles in general population timeseries studies of hospital admissions and mortality upon short-term exposures. In addition, panel studies of small patient samples will be presented assessing the role of ultrafine particles on early pathophysiological responses. The need for studies evaluating the role of long-term exposures to ultrafine particles and recent efforts will be discussed. The presentation will compare the results of studies on ultrafine particles to those of other regulated and unregulated air pollution parameters. In addition, the potential role of elevated personal exposures to ultrafine particles originating from time spent in micro environments with high levels of different types of ultrafine particles will be discussed.

Nucleation of ultrafine particles in the atmosphere

Markku Kulmala
University of Helsinki, Finland

ABSTRACT

The formation of new aerosol particles in the atmosphere, starting with the production of molecular clusters and their growth to larger sizes, is a world-wide phenomenon, with a significant contribution to aerosol particle number load and indirect radiative effects as well as urban air pollution. Understanding the very initial states of atmospheric aerosol formation requires detailed knowledge of the concentrations of neutral and charged clusters, on their chemical composition, and on the gaseous compounds participating in their formation and growth.

The recent development in measurement techniques (atmospheric mass spectrometry like (CI)-APi-ToF, Particle Size Magnifier, air ion spectrometers) and theoretical understanding (cluster dynamics, quantum chemistry, Nano-Kohler theory) has enabled us to study quantitatively atmospheric new particle formation and also find out the links between vapor sources, chemical reactions with different oxidants, cluster and nanoparticle dynamics. Actually we are able to give new insight into gastoparticle conversion, where several new steps have been found out e.g. new oxidants, enhanced particle growth via extra vapour after activation, multicomponent condensations. On the other hand this new knowledge can be applied in different processes in the other scientific and technological fields.

In light of our current understanding, atmospheric aerosol formation is initiated by photochemical reactions in the gas phase, in particular the formation of sulfuric acid and other vapors of very low volatility such as multifunctional organic compounds or iodine oxides. Pre-existing aerosol particles act as a sink for these vapors and nucleated clusters, thus inhibiting atmospheric aerosol. The intensity of solar radiation, atmospheric mixing conditions, and the ambient temperature and relative humidity affect aerosol formation via their influences on the abundance and properties of low-volatile vapors, molecular clusters and pre-existing larger particles. It seems that there is always more or less intensive clustering in the atmosphere but only some fraction of those clusters are able to growth to 3-4 nm and further to cloud condensation nuclei sizes.

In the presentation I will focus on:

- Environmental grand challenges
- Discovering the world below 3 nm: atmospheric clusters
- New particle formation; Gas-To-Particle conversion
- Continuous, comprehensive observations, SMEAR stations
- Air quality and climate change
- Holistic approach to solve air quality in Megacities
- Pan Eurasian Experiment (PEEX)

Black carbon, total and size-resolved particle number concentrations in urban areas near Schiphol airport (the Netherlands)

Keuken, M.P.[1], Moerman, M.[1], Zandveld, P.[1], Henzing, J.S.[1], Hoek, G.[2] and de Jonge, D.[3]

(1) TNO, Netherlands Organisation for Applied Research, Utrecht, the Netherlands
(2) Institute for Risk Assessment Sciences (IRAS), University of Utrecht, the Netherlands
(3) Public Health Service of Amsterdam (GGD), Amsterdam, the Netherlands
Contact: menno.keuken@tno.nl

ABSTRACT

The presence of black carbon, and size-resolved and total particle number concentrations (PNC) were investigated in the vicinity of Schiphol airport in the Netherlands, the fourth busiest airport in Europe. Continuous measurements were conducted between March and May 2014 at Adamse Bos, located 7 km from Schiphol, and in 2012 at Cabauw, a regional background site 40 km south of Schiphol. No significantly elevated black carbon levels were found near Schiphol. However, PNC increased during periods in which the wind direction was from Schiphol: at Cabauw by 20% and at Adamse Bos by a factor of three, from 14,100 (other wind directions) to 42,000 # cm^{-3} between 06.00 and 23.00. The size distribution of Schiphol-related PNC was dominated by ultrafine particles, ranging from 10 to 20 nm. Four relevant PN emission sources at Schiphol were identified as being responsible for the elevated PNC levels at Adamse Bos: take-off and climb-out on the Kaagbaan and Aalsmeerbaan runways, planes waiting at the gates, and landing on the Buitenveldertbaan runway. PN emissions from road traffic at and near the airport were less important than air traffic. The exposure to Schiphol-related PNC in urban areas northeast of Schiphol in Amsterdam and Amstelveen was estimated for 2012 using a Gaussian Plume model and compared with independent PNC measurements. The results showed that a considerable number of the 555,000 addresses in the modelling domain were exposed to elevated PNC. For example: 45,000 addresses suffered long-term exposure to an additional annual background PNC of 5-10,000 # cm^{-3} originating from Schiphol and 60,000 addresses suffered short-term exposure (14% of the time) of additional 10-15,000 # cm^{-3} originating from Schiphol. Further research on emission sources and the dispersion of PN is recommended and may support future studies on eventual health effects.

Modelling ultrafine particle concentrations at a street-level scale

Hans Hooyberghs[1], Wouter Lefebvre[1], Felix Deutsch[1], Sandy Adriaenssens[2], Elke Trimpeneers[2], Frans Fierens[2], Stijn Janssen[1]

1. VITO, Flemish Institute for Technological Research, Unit Environmental Modelling. Boeretang 200, B-2400 Mol, Belgium.
2. Belgian Interregional Environment Agency (IRCEL-CELINE), Kunstlaan 10-11, 1210 Brussels, Belgium

Contact: hans.hooyberghs@vito.be

ABSTRACT

In this study, an integrated model chain has been set up to assess the concentration of ultrafine particles at the local (street level) scale, including both regional variability as well as local variation in sources of air pollution. The model is subsequently validated using a measurement campaign for the city of Antwerp (Belgium).

The model chain starts from spatially and temporally distributed emissions based on the HBefa-methodology. These traffic emissions are subsequently used in IFDM, a bi-Gaussian plume model designed to simulate non-reactive pollutant dispersion at a local scale. To incorporate regional scale background concentrations, the model results are coupled to the output of a regional air quality model (LOTOS-EUROS). Finally, the effects of street-canyons are added using the OSPM-module, which takes into account the specific dispersion characteristics in the street canyon. This model chain (also known as the IFDM-OSPM model) has previously been used at VITO to successfully model the concentrations of nitrogen dioxide, ozone, particulate matter, elemental and black carbon, and has now, within the scope of the INTERREG IVB Joaquin project, been extended to model the concentrations of (total number of) ultrafine particles.

The methodology is validated over the city of Antwerp using measurement campaigns carried out in 2013. Although dynamical processes such as nucleation and coagulation are neglected in the local scale IFDM-OSPM model, in general, there is a good agreement between the measurements and the model output. Especially the spatial validation is highly successful, and thus the model is certainly suitable to compose maps of annual mean ultrafine particle concentrations and to identify hotspots on a local and regional scale.

This modelling exercise and the subsequent successful validation confirms the hypothesis that dynamical processes do not play a major role in the dispersion of ultrafine particles at the local and urban scale. Here the dispersion pattern is mainly governed by the dilution process which is well simulated by the IFDM-OSPM model.

Highly resolved ultrafine particle number concentration maps for the city of Zurich, Switzerland

M.D. Mueller[1], D. Hasenfratz[2], O. Saukh[2], M. Fierz[3], Ch. Hueglin[1]

(1) Empa, Swiss Federal Laboratories for Materials Science and Technology, Duebendorf, Switzerland.
(2) ETH Zurich, Computer Engineering and Networks Laboratory, Zurich, Switzerland.
(3) University of Applied Sciences and Arts Northwestern Switzerland, Windisch, Switzerland.

ABSTRACT

The tram-based OpenSense mobile sensor network compiled a comprehensive record of ultrafine particle data in the city of Zurich, Switzerland, for the years 2012-2014. The sensor network consisted of ten sensor nodes installed on the roof of streetcars operating on different services. Each node was equipped, among other sensors, with a particle counting device (miniature diffusion size classifier) and a GPS receiver both providing measurements at a rate of five seconds.

We modelled the UFP number concentration in the city of Zurich in two dedicated time periods (July-Sept 2013 and Dec 2013-Feb 2014) employing a statistical approach. This approach is based on Generalized Additive models (GAM) and utilizes the OpenSense UFP data set as well as georeferenced data as explanatory variables. Traffic related variables, information about the built environment and, due to the hilly topography of Zurich, elevation are the most important predictor variables. The UFP number concentration is mapped within the city of Zurich for 30 minutes periods by computing spatial predictions based on the derived models. The resulting UFP maps for the city of Zurich have a temporal resolution of 30 minutes and a spatial resolution of 10 by 10 m.

The performance of the modelling approach was analysed by comparing the mapped UFP concentrations to measurements of four permanent monitoring sites as well as to measurements obtained by pedestrians. In addition, we performed leave-one-out (i.e. sensor node) cross-validation. The accuracy of the statistical models is convincing in areas with geographic features well captured by the tram network. It partly declines for location types associated with a small number of measurements. However, the presented approach provides detailed insight into spatial and temporal variability of UFP levels in cities. It can be very useful for improved exposure estimation, for urban planning and for public information.

Atmospheric composition measurements for improving the high resolution modelling of the Brussels urban atmosphere

Alexander Mangold, Andy Delcloo, Veerle De Bock, Rafiq Hamdi
Royal Meteorological Institute of Belgium, 1180 Brussels, Belgium

ABSTRACT

The urban atmosphere is characterised by a high spatial and temporal variability. Its composition affects photochemistry, air quality and urban climate. Modelling the urban atmosphere at high spatial resolution is essential to study potential evolutions of the urban climate, which is relevant for decision makers. However, models are currently at their limit to simulate this variability precisely. One reason is the lack of high resolution input data for urban areas – both meteorological boundary conditions and precise emission data.

The Royal Meteorological Institute of Belgium is currently running the chemical transport model CHIMERE, coupled to the high resolution regional numerical weather prediction limited area model ALARO, at a spatial resolution of 7 km^2 for the BENELUX area. CHIMERE is a multi-scale chemical transport model, primarily designed to produce daily forecasts of ozone, aerosols and other pollutants and to make long term simulations for, e. g., emission control or climate scenarios. Recently, ALARO model has been tested to produce urban meteorological fields on a 1 km^2 grid for the Brussels area for 2013 and 2014. During a smog period in Brussels in March 2014, the operational NWP ALARO forecast was used to run CHIMERE at 7 km^2 resolution. The model was able to represent the day to day variability and also the elevated PM_{10} concentrations were well captured.

Since 2013 RMI gathers aerosol data in Brussels with a 7-wavelengths aethalometer (mass concentration of light-absorbing aerosols) and a 3 wavelengths integrating nephelometer (aerosol scattering coefficients, also proxy for PM). Further data from the ground-based air quality monitoring network is available through the Belgian Interregional Environment Agency for nine measurement sites for the Brussels region. The measured data is used to evaluate CHIMERE and to apply necessary adaptations with respect to emissions or boundary conditions. Our objective is to obtain an improved model for urban atmospheric composition at high spatial resolution – target is 1 km^2 grid size.

Alveolar epithelial cells initiate nanoparticle-induced acute lung inflammation

Shanze Chen, Renfu Yin, Kathrin Mutze, Melanie Königshoff, and Tobias Stoeger

Comprehensive Pneumology Center, Institute of Lung Biology and Disease, University Hospital, Ludwig-Maximilians-University and Helmholtz Zentrum München, Member of the German Center for Lung Research, Munich, Germany
Contact: tobias.stoeger@helmholtz-muenchen.de

ABSTRACT

RATIONALE: Inhalation of carbonaceous nanoparticles (CNP), a main constituent of urban air pollution, can trigger pulmonary inflammation. While alveolar macrophages initiate inflammation upon airway infection, their contribution to inflammation caused by sterile CNP remains unclear.

METHODS: To address whether alveolar macrophages initiate and/or contribute to CNP-induced lung inflammation, C57BL/6N mice were intratracheally instilled with 20 µg CNP (diameter: 7-12 nm) or vehicle. The course of pulmonary inflammation was monitored by bronchoalveolar lavage fluid (BALF) analysis over 7 days. Pro-inflammatory genes were analyzed in total BALF cells and alveolar macrophages, as well as $CD45^+$ and $CD45^-$ cells isolated from single cell lung suspensions.

RESULTS: CNP instillation induced an acute pulmonary inflammation, characterized by airspace neutrophilia with maximal BAL neutrophil numbers after 18 to 24hrs ($229\pm44 \times 10^3$ to $282\pm50 \times 10^3$ cells) and decline to baseline levels by day 7 ($11\pm4 \times 10^3$ cells). Highest BALF concentrations of the neutrophil-attracting chemokines CXCL-1 and -5 were measured at 12 to 18hrs (850±52 to 631±64 pg/ml and 639±59 to 656±35 pg/ml, compared to 28±6 pg/ml and 75±8 pg/ml for controls), while the highest Cxcl-1 and -5 lung mRNA levels were observed at 12hrs (180 and 320 fold over controls). Profiling of alveolar macrophages revealed no effect of the CNP instillation on their inflammatory status (Nos2, Tnf, Il1b, Cxcl2 gene expression). In contrast, Cxcl1, -5, and Csf2 expression was induced 50 fold in freshly isolated primary alveolar epithelial cells (95±3% positive for SP-C and EpCAM expression). Non-lavageable $CD45^+$ leukocytes possessed the strongest Tnf and Cxcl2 signals, but the induction was much less pronounced (~2fold) and did not precede Cxcl1 and -5 expression, thereby suggesting that these cell population does not initiate chemokine release.

CONCLUSIONS: Our data suggests that alveolar epithelial cell-derived chemokines (Cxcl1 and Cxcl5) initiate CNP triggered neutrophil recruitment to the airspace, while alveolar macrophages seem to be dispensable for the onset of the inflammatory response in response to nanoparticles.

Automated Exposure station for the Air-liquid interface exposure of human lung cell cultures towards aerosols

S. Mülhopt[1], S. Diabaté[2], C. Schlager[1], M. Dilger[2], T. Krebs[3], H.-R. Paur[1]

1 Karlsruhe Institute of Technology, Institute for Technical Chemistry, Eggenstein-Leopoldshafen, Germany
2 Karlsruhe Institute of Technology, Institute of Toxicology and Genetics, Eggenstein-Leopoldshafen, Germany
3 Vitrocell Systems GmbH, Waldkirch, Germany.

ABSTRACT

Most in vitro studies on aerosol health effects rely on submerged exposure of collected particulate matter, suspended in the medium. However this method does not represent the actual process in the human lung. It even may change the properties of the investigated aerosol. Research at the air-liquid interface avoids these disadvantages, but requires a well-engineered system to guarantee reproducible conditions. Therefore KIT and VITROCELL Systems developed a fully automated Exposure Station. It offers a lab scale measurement technique for parallel exposure up to 24 human lung cell cultures towards aerosols. The exposure station provides direct aerosol sampling via a size selective inlet, a control system for flow, temperature, and humidity to model the conditions in the human lung and a programmable controller leading the user through standard exposure protocols while recording all data. The deposited particle dose is monitored online. An internal negative control using humidified synthetic air is also implemented as an electrostatic particle deposition to increase the particle dose per time. Several measurement campaigns were successfully performed with these systems: Aerosols from different biomass heaters and aerosolised industrial nanoparticles were characterised with respect to cytotoxicity, ROS-formation, and inflammatory effects using established methods as well as omics methods.

Day-to-day variability of toxic events induced by organic compounds bound to size segregated atmospheric aerosol

Jan Topinka[1]*, Pavel Rossner Jr.[1], Alena Milcová[1], Jana Schmuczerová[1], Katerina Pencíková[2], Andrea Rossnerová[2], Antonín Ambrož[2], Jitka Štolcpartová[2,3],c, Miroslav Machala[2], Jan Hovorka[3]

1 Department of Genetic Ecotoxicology, Institute of Experimental Medicine, Czech Academy of Sciences,Vídenská 1083, 142 20 Prague 4, Czech Republic
2 Department of Chemistry and Toxicology, Veterinary Research Institute, Hudcova 70, 62100 Brno, Czech Republic;
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ABSTRACT

Complex mixtures of organic compounds, including polycyclic aromatic hydrocarbons (PAHs), are present in various size fractions in air particulate matter (PM) and have been associated with many adverse health effects in humans, such as respiratory diseases and cancer. This study quantified the temporal variability of carcinogenic polycyclic aromatic hydrocarbons (c-PAHs), genotoxicity, oxidative DNA damage and dioxin activity of the extractable organic matter (EOM) of atmospheric aerosol particles of aerodynamic diameter (d_{ae}, μm) coarse ($1<d_{ae}<10$), upper ($0.5<d_{ae}<1$) and lower ($0.17<d_{ae}<0.5$) accumulation and ultrafine (<0.17) fractions. The aerosol was collected in a heavily polluted residential district. The upper accumulation fraction formed most of the aerosol mass for 22 of the 26 study days and contained ~44% of total c-PAHs, while the ultrafine fraction contained only ~11%. DNA adduct levels suggested a crucial contribution of c-PAHs bound to the upper accumulation fraction. The dioxin activity was also driven primarily by c-PAH concentrations. In contrast, oxidative DNA damage was not related to c-PAHs, as a negative correlation with c-PAHs was observed. These results suggest that genotoxicity and dioxin activity are the major toxic effects of organic compounds bound to size segregated aerosol, while oxidative DNA damage is not induced by EOM.

The study was supported by the Czech Science Foundation (CZ: P503/12/G147).

An Estimation of the Marine Sources Impact on PM_{10} Levels in Northern France

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ABSTRACT

The Nord-Pas-de-Calais Region is one of the most concerned area in France by exceeding of the PM_{10} daily mean limit value (50 µg m^{-3}). For a better understanding of these phenomena, the most complete identification of PM_{10} is crucial. In this region, numerous studies aiming to the characterization and identification of particles in urban area and in the vicinity of industrial emission have been performed. Nevertheless, the particulate atmospheric background level could also be high in coastline sites without any direct impact of urban and industrial sources. On the one hand, the influence of long range transport and gas to particle conversion should not be neglected. On the other hand, there is still a lack about the impact of emissions resulting from the marine compartment including natural emissions such as sea salts [1] and anthropogenic emissions linked to the marine traffic especially in the English Channel, together with the Straits of Dover, that forms a narrow corridor with one of the greatest concentration of shipping in the world [2] (700 to 800 vessels sailing per day). In this work, an intense PM_{10} sampling and measurement campaign has been done continuously from 2013/01/01 to 2014/04/15 at the Cape Gris Nez, a coastal French site selected to study marine impact, in front of the Straits of Dover. A complementary campaign has been performed in the port of Calais, from 2014/01/28 to 2014/04/21. PM_{10} levels were measured using MP101 analyzer and collected using Digitel® DA80 sampler (30m^3/h, 24h, Pall® QAT-UP filter). The characterization of PM_{10} was performed considering trace metals, water soluble ions, EC/OC, biomass burning and biogenic particles organic tracers. These chemical parameters were considered to explain PM_{10} levels observed in the Nord Pas-de-Calais Region and to estimate the contribution of the maritime sector to the PM_{10} levels in coastal sites.

Références

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[2] The impact of international shipping on European air quality and climate forcing, European Environment Agency, Technical report No 4/2013. doi:10.2800/75763

Ultra-low emission wood combustion by seamless adaption of an electrostatic precipitator to a modern grate boiler

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ABSTRACT

Combustion of biomass uses sustainable, domestic fuels, which are available in large quantities at competitive costs and deliver about 90 % of the regenerative heat in Germany. The emission of ultrafine particles from wood combustion is of concern due to their health effects. Accordingly German legislation (1st BImSchV) requires a further reduction of particle emission limits to below 20 mg/m^3 for new wood fired boilers starting from 2015.

The technology of wood combustion (wood-chips, pellets, logs) by automatic grate boilers has considerably advanced during recent years. Boiler efficiencies above 90 % and low emissions of particles and gaseous pollutants are state of the art. Modern grate boilers achieve particle emissions of 10–100 mg/m^3, depending on the fuel quality. Thus further measures are mandatory for new boilers to comply with the new legislation.

Recently compact and cost-efficient Carola®-precipitators have been developed, which provide high particle collection efficiency for submicron particles. Reliable long-term operation of these precipitators was demonstrated at test facilities and particle concentrations below the new emission limits were achieved.

Besides the technological readiness of boilers and precipitators the combination of both units is an important task concerning the market penetration of the technology. With respect to competitiveness of wood fired boilers their cost should increase only moderately due to the installation of particle control devices. This challenge can be met by seamless adaptation of the precipitator into the boiler, which opens several opportunities for technological progress and cost reduction as well. In this project a first prototype is manufactured, which combines a full mechanical and electronic adaptation of an electrostatic precipitator to a wood fired grate boiler. By adaptation of the Carola®-precipitator to the HDG wood chip boiler the technological complexity of the installation is reduced with respect to ducts, casing and electronic components. More over the adaptation allows electronic communication between the boiler and the precipitator, which improves the reliability of the whole unit. The first operational experience of this novelty will be discussed. Tests at industrial and domestic boilers are in progress and will be discussed.

On the status of discussion within the International Maritime Organization about the consideration of the impact on the arctic of emissions of black carbon from international shipping

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ABSTRACT

This paper addresses the actual discussion on the impact on the arctic of emissions of black carbon (BC) from international shipping, highlighting the unclear situation of a comprehensive trans-sectoral definition of BC and related measurement procedures.

The selection of a definition for Black Carbon that is intrinsically linked to a measurement method has impeded the building of consensus towards a clear recommendation for a definition of Black Carbon most appropriate for international shipping. The two definitions currently under consideration by the Sub-Committee have clear limitations. Equivalent Black Carbon (eBC), defined as „Black Carbon derived from optical absorption methods, that utilizes a suitable mass-specific coefficient," is limited by its lack of alignment with accepted international and scientific definitions of Black Carbon based on measureable, physical properties. The alternative definition, Light Absorbing Carbon (LAC), is meant to encompass a wider variety of light absorbing carbonaceous compounds, including so-called brown carbon (BrC). To date, no peer-reviewed studies have been submitted to the Sub-Committee demonstrating that Black Carbon emissions from marine engines could be measured in a repeatable basis based upon the LAC definition. The presentation will report on the status of discussion about definition and provide information about limitations and advantages of the so far proposed measurement methods.

References:

International Maritime Organization (IMO): Sub-committee on Pollution Prevention and Response, PPR 1/16: Report to the Marine Environment Protection Committee MEPC, London, 2014. http://www.imo.org/Pages/home.aspx
International Council on Clean Transportation (ICCT): Marine Black Carbon Emissions : Identifying research gaps, a technical workshop, Ottawa, 2014. http://www.theicct.org/events/marine-black-carbon-emissions-identifying-research-gaps

Short CV of the Author:

Dipl.-Ing. Peter Lauer, born 1968, studied mechanical engineering at the Leibniz University Hannover, Germany. Since 1995 he is with MAN Diesel & Turbo SE, Augsburg, Germany, department basic research & development 4-stroke engines, exhaust gas emissions and after treatment.

MONDAY, 4 MAY

10:30 – 11:00
Opening
EUROPASAAL

11:00 – 11:45
Keynote Session A.1
EUROPASAAL

11:45 – 12:30
Keynote Session A.2
EUROPASAAL

Lunch
FOYER/PATIO

13:45 – 15:25
Session B – Measurement, Chemistry and Modelling 1
EUROPASAAL

13:45 – 15:25
Session C – Health effects
STUTTGART/KARLSRUHE

Coffee Break
FOYER

15:45 – 17:25
Session D – Sources and Mitigation of Emissions
EUROPASAAL

15:45 – 17:25
Session E – Measurement, Chemistry and Modelling 2
STUTTGART/KARLSRUHE

17:30 – 19:00
Poster Session F & Buffet
FOYER/PATIO

TUESDAY, 5 MAY

09:00 – 09:45
Keynote Session G.1
EUROPASAAL

09:45 – 10:30
Keynote Session G.2
EUROPASAAL

Coffee Break
FOYER

10:45 – 12:25
Session H – Measurement Methods
EUROPASAAL

10:45 – 12:25
Session I – Monitoring and Exposure 1
STUTTGART/KARLSRUHE

Lunch
FOYER/PATIO

13:25 – 15:05
Session J – Monitoring and Exposure 2

15:05 – 15:45
Concluding discussion
EUROPASAAL

16:00
EFCA Board Meeting
MANNHEIM

Nanoparticle emissions from thermal desorption/regenerative oxidation of contaminated soils

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ABSTRACT

The investigation involved a two-step thermal desorption/regenerative oxidation process. The plant nominally treats 15 t h^{-1} of contaminated (mostly hydrocarbons) soil. GPL is used as an auxiliary fuel during thermal desorption phase. The flue gas is treated with a baghouse and a glass fiber filter unit before entering the post-combustor for regenerative oxidation. The exhaust from oxidation process is directly released to the stack.

For determining properly the primary particles at stack gas conditions as well as the evaluation of the effects from the fractions of condensable origin, the investigation adopted two different measurement designs, namely hot sampling and cold sampling. In the latter, the flue gas was diluted and cooled with clean, dry dilution air supplied at ambient temperature, aimed to trigger the nucleation and condensation of semivolatile species. On the other hand, the hot sampling aimed to keep the particles as unbiased as possible from the stack conditions. Number concentrations and size distribution were measured in the sampled stream with an electrical low pressure impactor. The comparison of the results both in terms of number concentrations and of size distributions provided insights about the share of condensation effects on total particulates emitted and information on the possible variations in particle emissions once the flue gas bearing particles is released into the atmosphere. Average particle number emission factors were calculated based on nominal plant capacity.

Total number emissions are calculated to be in the order of 10^{15}-10^{16} particles/t_{soil} for various measurement conditions. Nanoparticles (dp < 50 nm) accounted for more than 80 % of the total number emissions.

Investigating the chemical composition of sub-100 nm particles with chemical ionization mass spectrometry

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3 Department of Chemistry and Molecular Biology, University of Gothenburg, Gothenburg, Sweden
4 Research and Development Aerosol Research, Finnish Meteorological Institute, Helsinki, Finland

ABSTRACT

The formation of new atmospheric particles and their subsequent growth can eventually lead to particles that can be climate-relevant via cloud interactions. Chemical analysis of particle phase composition and the surrounding gas phase on molecular level are crucial to increase our understanding of the processes involved in new particle and particle mass formation, of importance also from a public health perspective. Chemical ionization mass spectrometry allows the detection and quantification of chemical compounds with high temporal resolution. The ionization method is selective (compounds analyzed depend on the reagent ion chosen) and soft (little fragmentation of analytes).

We used a chemical ionization high-resolution time-of-flight mass spectrometer (with acetate as reagent ions) coupled to a Filter Inlet for Gases and Aerosols (FIGAERO) and a Micro Orifice Uniform Deposit Impactor (MOUDI) to identify and quantify oxygenated organic compounds such as carboxylic acids in sub-100 nm particles in the boreal forest in Finland during spring time. New particle formation (NPF) events were observed frequently during the course of a 3-week campaign.

Results show that carboxylic acids and structurally related compounds make up a significant fraction (~75%) of total organic ultrafine particle mass. The oxidation state of organic compounds in sub-100nm particles measured during NPF events is increased compared to that of compounds measured in larger particles, indicating that with increasing particle size less oxygenated and thus more volatile compounds contribute to particle mass formation.

Frequency of new particle formation events in high insolation urban environments

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ABSTRACT

Road traffic emissions are often considered the main source of ultrafine particles (UFP) in urban environments. However, recent studies worldwide have shown that -in high insolation urban regions at least -new particle formation events can also contribute to UFP. In order to quantify such events we systematically studied three cities located in predominantly sunny environments: Barcelona, Madrid and Brisbane. Three long term datasets (1–2 years) of fine and ultrafine particle number size distributions (measured by SMPS, Scanning Mobility Particle Sizer) were analysed. By applying *k*-Means clustering analysis, four main classes of aerosol size distributions were found: "Traffic" (prevailing 44–63 % of the time), "Background Pollution" (13–22 %), "Nucleation" (14–19 %) and "Specific case" (7–20 %) the latter being site specific. Measurements from Rome and Los Angeles were also included to complement the study. The daily variation of the average UFP concentrations for a typical nucleation day at each site revealed a similar pattern for all cities, with three distinct particle bursts. A morning and an evening spike reflected traffic rush hours, whereas a third one at midday showed nucleation events. The photochemically nucleated particles burst lasted 1–4 hours, reaching sizes of 30–40 nm. On average, the occurrence of particle size spectra dominated by nucleation events was 16 % of the time, showing the importance of this process as a source of UFP in urban environments exposed to high solar radiation. Although the percentage of days with nucleation events averaged 68 %, only 28 % of the days presented uninterrupted events lasting for 4 hours or more, evidencing that atmospheric conditions in urban environments are not favourable to the growth of photochemically nucleated particles.

Role of fine and ultrafine particles in the formation of haze in Beijing, China

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ABSTRACT

A lot of emission reduction measures to improve the air quality in Beijing were performed during the Olympic Summer Games in 2008, which has cut down coarse particles largely. But high air pollution episodes, known as haze, have become much more frequent and influence visibility and human health. In order to discriminate the composition of $PM_{2.5}$ source attribution, particle characteristics and external impacts on the PM levels were investigated. Two sequential High-Volume Samplers (Digitel DHA-80, Hegnau, Switzerland) were operated to collect $PM_{2.5}$ samples (for 24 hours, but during haze for 4 hours) at a roof site automatically from 10 April to 8 June 2013. The inorganic elements, inorganic water-soluble ions, EC and OC as well as Levoglucosan, eleven hopane substances and fifteen PAHs of $PM_{2.5}$ were analysed by ICP-MS, IC, thermal/optical carbon analyser and in situ derivatisation direct thermal desorption gas chromatography time-of-flight mass spectrometry (IDTD-GC-TOFMS), respectively.

Source apportionment by PMF (version 3.0, U.S. EPA) on the basis of the chemical composition analyses and backward trajectory cluster analyses were applied to identify the sources of PM. During haze especially NO_3^-, SO_4^{2-} and NH_4^+ mass concentrations were 6 times higher than during clear days. This indicates that major chemical species of $PM_{2.5}$ during haze are originated from anthropogenic sources. The Hopane and Homohopane indexes suggest a high contribution of vehicle exhaust emissions to haze formation. The PMF analysis provides as main sources: secondary inorganic ion formation, biomass burning, traffic, mineral dust emissions, coal combustion and industry. All the primary sources contribute to UFP exposure too, either by emissions or by formation of new particles from the gas phase. Further, haze was found to be always accompanied by southerly air flows (industry and cities are about 100 km away), high relative humidity, low mixing layer height and low wind speed, i.e. stagnant weather conditions.

BC monitoring as a proxy of the UFP concentration

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ABSTRACT

Black carbon (BC) is a component of ambient air particulate matter. It is formed through the incomplete combustion of fossil fuels and biomass. These soot particles are found in the sub-micrometer size range and can be used as a proxy of total number concentration (TNC), especially in traffic areas where BC represent an important part of ultrafine particles (UFP) concentration. Indeed, BC is primarily responsible for the absorption of visible light. Aethalometers® are frequently used devices that optically detect the changing absorption of light transmitted through a filter ticket where dust is collected. These instruments are quite basic and provide data with a good recovery at acceptable cost in comparison with monitors required for direct UFP measurement such as condensation particle counter (CPC) or scanning mobility particle sizer (SMPS). In this presentation the result of parallel measurements of BC and UFP in different locations, conditions and periods will be presented. Advantages and limitations of BC measurements compared to direct UFP measurement will be highlighted and discussed. Managing Aethalometers® within a network required a strict standard operating procedure (SOP) and regular quality controls. The procedure followed to calibrate the monitors and results of a specific ringtest organised at the Belgian level with more than 15 instruments will also be presented. The outcomes of this intercomparison study provides users with information on deviations which can be expected in practice for each type of models included in the tests and allows estimation of the final uncertainty of the measurement.

Comparison between ultrafine and fine particulate matter: chemical characterization and in vitro toxicity in human bronchial epithelial cells BEAS-2B

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ABSTRACT

During the last few years, the induction of toxicological mechanisms by ultrafine particles (UFPs) has become one of the most studied topics in toxicology and a subject of huge debates. However, the process involved in the toxicity of these particles remains poorly understood, mainly because UFPs are uniquely complex owing to their physicochemical characteristics. Fine particles (FPs) and UFPs samples were collected at an urban and a rural site in Lebanon. Then the samples were chemically characterized to identify their composition and their different emission sources. UFPs were found more enriched in trace elements (Ag, Cd, Ni, Pb, Sb, Sn and V), secondary inorganic ions ($SO4^{2-}$ and NH_4^+), total carbon and organic compounds (PAHs, PCDDs and PCDFs) when compared to FPs collected at the same site. For toxicological analysis, two UFPs samples were prepared: water-UFPs suspension (UFP_w) and UFPs organic extract (UFP_{org}). BEAS-2B cells were then exposed for 24, 48 and 72 h to increased concentrations of FPs and UFPs samples in order to assess their cytotoxicity: UFPs samples caused earlier alterations of mitochondrial metabolism and membrane integrity from the lowest particle concentrations. Hence, cells were exposed to FPs and UFPs in order to investigate AhR and ARNT genes expression, as well as AhR/ARNT regulated genes (AhRR, CYP1A1, CYP1B1 and NQO1). Our findings showed that AhR and ARNT mRNA expression was not induced, while a significant induction was found for CYP1A1, CYP1B1 and AhRR genes expression after cells exposure to UFPorg and to a lesser extent to UFPw and FPs samples, indicating the induction of metabolizing enzymes expression which can lead to metabolic biotransformation of organic compounds into more toxic and carcinogenic metabolites. miR-21 gene expression, H2AX phosphorylation and telomerase activity were also evaluated for FPs and were significantly increased in BEAS-2B cells, in a dose and site dependent manner.
Keywords: BEAS-2B cells, chemical characterization, fine particles, lung toxicity, and ultrafine particles.

Measurement of ultrafine particles from small non-road engines under real-world operating conditions

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ABSTRACT

Small non-road internal combustion engines such as those used in lawnmowers and other garden machinery are not currently subject to any particulate matter limits, and can be a considerable source of ultrafine particles.

In this work, real-world emissions from lawnmowers, weedeaters and other equipment have been measured with an improvised portable off-board apparatus featuring a full-flow dilution tunnel. Emissions of hydrocarbons, carbon monoxide, nitrogen oxides, carbon dioxide and particulate matter have been measured online, and miligrams of particulate matter were sampled on quartz fiber filters for subsequent chemical analyses and toxicological assays.

The measurements suggests that field measurement of small engines is technologically feasible and that, when necessary, reproducible results can be obtained when care is taken to maintain stable operating conditions. The results are preliminary and suggest that particulate matter emissions from small engines are far from negligible.

With ambient concentrations of ultrafine particles still being excessively high in most larger cities in Europe, and with the emissions standards for on-road engines have tightened considerably to the point that the concentrations of ultrafine particles in the exhaust of welldesigned, dutifully maintained and reasonably operated diesel engines equipped with particle filters approach ambient levels in polluted cities, targeting the relatively simple technology of small gasoline engines offers considerable potential for improvement. Among others, a question of whether public subsidies of small electric machinery would, per Euro spent, bring larger benefits than subsidies of electric cars, is therefore raised. Another question arising out of the results is whether, given the close proximity of the operator to the exhaust, ultrafine particles from small engines are even more of a risk to the health of their operators than to the regional air quality.

Sponsored by the EU LIFE+ program (LIFE10 ENV/CZ/651, MEDETOX), European Social Fund (CZ.1.07/2.3.00/30.0034), and Czech Ministry of Education (NPU LO1311).

Water-soluble ions in PM2.5. paricle fraction in Zagreb air, Croatia

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ABSTRACT

Airborne particulate matter is a complex mixture of solid particles and liquid droplets suspended in the air, and have been found widely associated with health problems. They can also influence many atmospheric processes including visibility variations and cloud formation, and play a major rule in acidification of rainfalls and affect climate. The analyses of the aqueous extract of the aerosols shows, that the chemicals originating from motor vehicle exhausts, soil dust resuspension and industry emission, mainly occur in an easily water-soluble form, and are the dominant chemical species in aerosol particles, especially $PM_{2.5}$.

Daily $PM_{2.5}$ samples were taken over a year 2014 in northern part of Zagreb air with moderate to high traffic density. Samples were analysed for water-soluble anion species (Cl^-, NO_3^-, SO_4^{2-},) and cation species (Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}), to investigate the relationship between pollutant mass concentrations, contribution of measured species to $PM_{2.5}$ mass and the prediction of the pollutant sources. Mass concentrations of $PM_{2.5}$ particle fraction were determined by gravimetry. Water-soluble ionic species were analysed using ion chromatography.

Annual average $PM_{2.5}$ mass concentration was 19.6 μg m^{-3}. The annual average ion mass concentrations followed the order $SO_4^{2-} > NO_3^- > NH_4^+ > K^+ > Ca^{2+} > Cl^- > Na^+ > Mg^{2+}$. $PM_{2.5}$ mass concentration was significantly influenced by the season, reaching their high values in the winter. The prediction of the pollutant sources, we ran the principal component analysis (PCA), which was performed using the STATISTICA 12.0 statistical packages.

KEY WORDS: air pollution, airborne particle, anion species, cation species,

Sources and distribution of ultrafine atmospheric aerosol measured in the city of Leicester (UK)

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ABSTRACT

The poster will explore the sources and distribution of ultrafine atmospheric aerosol (UFP, particles in diameter 20-100 nm) measured in the city of Leicester (UK). The effects of meteorological conditions, particularly wind speed and wind direction, on the observed distribution of ultrafine particles will be detailed.

The study presents the results from an experimental investigation into the particle number concentration and size distribution of UFPs, with measurements taken at the Automatic Urban and Rural Network (AURN) monitoring site in Leicester. The monitoring was performed as part of the EU project JOAQUIN (Joint Air Quality Initiative; www.joaquin.eu) supported by the INTERREG IVB NEW programme. The particle number concentrations were measured by a water-based condensation particle counter (W-CPC) (TSI model 3783), and the particle size distributions were measured by an Ultrafine Particle monitor (UFP TSI model 3031), between December 2013 and November 2014. Particle number concentrations in urban areas such as the AURN site depend strongly on meteorological conditions and particulate source (traffic, and long-range transport). The temporal and seasonal variations of UFP were investigated at the AURN site. The overall average number concentrations of UFP in winter, spring, summer and fall were 5.7×10^3, 5.4×10^3, 5.18×10^3 and 5.45×10^3 cm^{-3}, respectively. Weak seasonal variation in number concentration was observed. The annual average number concentrations of nucleation mode(N_{nuc}), Aitken mode(N_{Aitken}) and ultrafine (N_{UFP}) particles were 1.45×10^3, 4.0×10^3 and $5.4^3 \times 10^3$ cm^{-3}, respectively. Correlation coefficients where calculated between three modes. Overall, the results support the notion that local traffic exhaust emissions were a major contributor of the air pollution (UFP) observed in morning and afternoon rush hours which was dominated by the Aitken mode size particles.

Evaluation of the impact of sulfur poisoning on catalytic stripper technology

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ABSTRACT

A catalytic stripper is a heated catalytic element used to remove the semi-volatile fraction of an exhaust aerosol, leaving the solid fraction (a surrogate of "black carbon") to be further quantified. Sulfur dioxide (SO_2) incident on a catalyst reduces its lifetime due to "poisoning" whereby the sulfur stores on the catalyst washcoat. Incident sulfur can be adsorbed and stored as SO_2 or can be oxidized and combine chemically with the washcoat material. Additionally, sulfur can pass through the catalyst unchanged (remain SO_2) or be oxidized and emitted as SO_3. The latter leads to the formation of sulfuric acid particles.

The goal of this proposed research is to better understand these effects for a specific catalyst formulation and prevailing conditions (e.g. temperature, flowrate, etc). The objectives are to: (1) measure the sulfur storage capacity of a 1.5 and 8 L/min catalytic stripper when operated at 350 °C and challenged with 100 ppm sulfur, (2) determine whether sulfur poisoning can be reversed by heating sulfated catalysts to 550 °C in air, and (3) determine whether sulfur poisoning can be reversed by heating sulfated catalysts to 550 °C in 2 % v/v H_2 in N_2.

To determine sulfur storage capacity, a low concentration of SO_2 (100 ppm) is mixed with air and used to challenge the catalysts. The determination of storage capacity is not impacted by the upstream concentration of SO_2, so 100 ppm is a nominal value (Limousy et al., 2003). The outlet concentration is monitored continuously to generate a typical SO_2 loading curve. The integral of this curve is approximately the sulfur storage capacity (Amanatidis et al., 2013). To determine whether this poisoning can be reversed with either heat or a reducing environment, an apparatus was built to desorb SO_2 from poisoned catalysts. Results are presented in context with estimations of typical sulfur exposure levels.

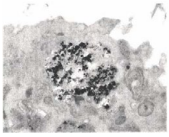
References

Amanatidis, S., Ntziachristos, L., Giechaskiel, B., Katsaounis, D., Samaras, Z., & Bergmann, A. (2013). Evaluation of an oxidation catalyst ("catalytic stripper") in eliminating volatile material from combustion aerosol. J. Aerosol Sci, 57, 144–155.
Limousy, L., Mahzoul, H., Brilhac, J.F., Gilot, P., Garin, F., & Maire, G. (2003). SO2 sorption on fresh and aged SOx traps. Applied Catalysis B: Environ, 42, 237–249.

WMA Statement on the Prevention of AOr pollution due to Vehicle Emissions

Heinz Fuchsig[1], Helene Wöger[2], Reiner Brettenthaler[3]

1 Umweltreferat der Österreichischen Ärztekammer ÖÄK,
2 Auslandsreferat der ÖÄK
3 World Medical Association



Dieselpartikel in Aleveolen eines 3 Monate alten Kindes (Bunn, Thorax 56:932,2001)

Adopted by the 65th World Medical Assembly (WMA), Durban, South Africa, October 2014. The WMA recommends that all National Medical Associations should encourage their respective goverments to:

1. Introduce best available technology (BAT) standards for all new diesel vehicles (on road and off-road).
2. Incentivise retrofitting with BAT filters for all in-use engines.
3. Monitor and limit the concentration of nanosize soot particles in the urban breathing air.
4. Conduct epidemiological studies detecting and differentiating the health effects of ultrafine particles.
5. Build professional and public awareness of teh importance of diesel soot and the existing methods of eliminating the particles.
6. Contribute to developing strategies to protect people from soot particles in aircraft passenger cabins, trains, homes and in the general environment. These strategies should include plans to develop and increase use of public transportation systems.

Measuring 1-3 nm particles in urban air

Joonas Vanhanen[1], Minna Väkevä[1], Katrianne Lehtipalo[2],
Jyri Mikkilä[2], Stephan Pannek[3], Stéphane Loyen[4], Johan van Lieverlooy[4], Markku Kulmala[2]
[1]Airmodus Ltd., Pietari Kalmin katu 1 F 1, 00560 Helsinki, Finland
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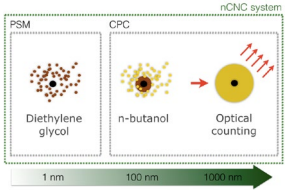
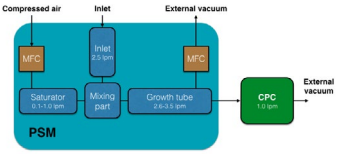
[3]MLU Messtechnik für Luft und Umwelt GmbH, Germany
[4]Envicontrol, Belgium, France, Netherlands
E-mail joonas.vanhanen@airmodus.com

Principle of detecting the smallest particles



A11 flow diagram



A11 nCNC

Measurement technology:

- Two stages of activation and condensation to detect particles as small as 1 nm in diameter.
- Mixing type activation for size resolved measurements (1-3nm)

Nucleation in urban environment:

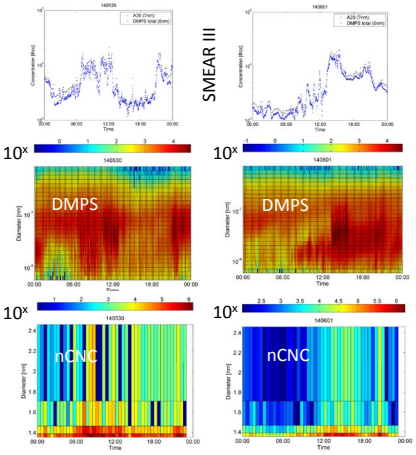
- Frequent new particle formation events measured at the SMEAR III station
- Urban background station where most of the ultrafine particles come from the local traffic emissions
- Measurements with A11 nCNC and DMPS coinside; **cluster growth detected**

Road side measurements:

- Measurement site in Helsinki; frequent traffic with lots of busses (diesel; all above euro 2, 50% better than euro 4)
- Clear correlation between A11 (cut-off at 1.3 nm) and A20 butanol CPC (cut-off 5 nm)
- During night time A11:A22 = 1
- Daytime lots of high concentration events from cars passing by
  - A11 concentration higher than A20

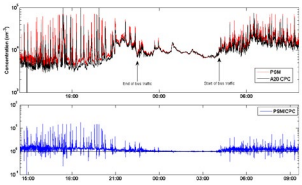
➡ **Particles 1-5 nm detected**

Measurements in Helsinki – urban background & near road



Friday 30th of May — Saturday 1st of June

University Campus in Kumpula, above a street with a bus stop



Data by D. Wimmer, University of Helsinki

Further reading:
www.airmodus.com → Highlights → Publications

Envicontrol MLU AIRMODUS

Health adverse effects within the population neighboring a landfill: Cd and Pb impregnation, oxidative stress and nephrotoxicity

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ABSTRACT

This case-control study dealt with the health adverse effects within the population neighboring the Mbeubeuss waste dump, which is located near the district of Malika (Diamalaye II) in Dakar (Senegal). All the household and industrial waste arising from Dakar are stored in this open landfill without being covered and are therefore possible sources of Pb and Cd contaminated air emissions and lixiviates. The objective of this study is part of improving the health of the population neighboring Mbeubeuss by determining Pb and Cd concentrations both in environment and humans, and studying possible renal function alterations within the adults.

Soil and air samples were collected in the control site (Darou Salam) and the waste dump neighboring site (Diamalaye II). Control and exposed adults were recruited as living in Darou Salam (n = 52) and in Diamalaye II (n = 77). Pb and Cd concentrations in soil, air and biological samples were determined. Moreover, we were interested in analyzing some impregnation (zinc protoporphyrin, d-aminolevulinic acid dehydratase) and oxidative stress biomarkers (malonedialdehyde, gluthatione status), in addition to several nephrotoxicity parameters (creatinuria, proteinuria, lactate dehydrogenase, CC16 protein, glutathione S-transferase-alpha and retinol binding protein) in blood and/or urine.

The results showed the signi.cant Pb and Cd contamination of the soil and air samples derived from the landfill, and therefore of the neighboring population of adults. This critical exposure to environmental Pb and Cd had some harmful consequences for their health, as shown by the reported oxidative stress and nephrotoxicity signs.
Keywords: Pb and Cd environmental exposure, impregnation markers, landfill, nephrotoxicity markers.

The effect of a thermal denuder on the measurement of black carbon generated in a diesel engine

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ABSTRACT

Black carbon (BC) has been studied for many years since it was known to act as a positive radiative forcing. Not only the environmental implication but also a health concern of diesel exhaust as carcinogenic creates necessity for the research of the BC. The BC is prevalent in the ambient aerosol due to the soot generated in diesel engines. In this situation, we have initiated the investigation of the effect of a thermal denuder on the measurement of BC. Usually, mass concentration of BC is measured without removing any volatile compounds. The BC is produced due to incomplete combustion in flames, engine and so forth. The BC may contain volatile compounds, which cause bias for the measurement, especially for the filter-based techniques due to the intrinsic nature of the filter itself. In this research, we show that the BC measurement is affected by the installation of thermal denuder in front of the measurement instrument. We employed a Multi-angle absorption photometer (MAAP) to measure the BC. The diesel BC was produced from a commercially available 2.0L variable-geometry turbocharger (VGT) diesel sport utility vehicle (SUV) and was introduced into MAAP through a sample inlet. The diesel BC was monitored in real time. A home-made thermal denuder was installed in front of the BC measurement instrument. The temperature of the thermal denuder was maintained at approximately 250 degC, where the volatile compounds included in the diesel exhaust are supposed to be removed. BC measured with the thermal denuder was compared to that measured without the thermal denuder for the idle condition. The BC was reduced as soon as the thermal denuder was operated. However, the BC was increased back to the value that was measured when the thermal denuder was not operated. Further study will be continued to elucidate the remaining questions.

Ultrafine particles in the urban atmosphere

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ABSTRACT

Concentrations of ultrafine particles are typically elevated within cities relative to the surrounding rural areas. This is because of the high density of sources, most notably road traffic, within cities, and the large condensation sink provided by elevated concentrations of particulate matter within cities which has a tendency to suppress regional nucleation processes. The fullest dataset on ultrafine particles in urban areas derives from the deployment of condensation particle counters and relevant results will be described, using other tracers to distinguish source processes. Whilst particle number counts provide a good comparator of ultrafine particle abundance between cities, they give little information on sources other than through their spatial distribution. Evaluation of sources is typically based either upon the disaggregation of measured particle size distributions into their component source distributions which can then be tentatively associated with individual sources, or through sampling of a PM_1 size fraction which is subjected to chemical analysis. The two approaches are essentially complementary, although very rarely if ever applied together, and relevant results will be discussed. Examples will be given of the application of a range of receptor modelling methods to particle size distribution data to identify contributing sources. Not only sources, but also sinks of ultrafine particles are of considerable importance and these will also be considered.

Dramatic increase projected in mortality attributable to fine particulate air pollution

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ABSTRACT

Assessments of the Global Burden of Disease (GBD) have been based on epidemiological cohort studies that connect premature mortality to a wide range of causes, including longterm health impacts by ozone and fine particulate matter with a diameter smaller than 2.5 μm ($PM_{2.5}$). Quantifying the mortality attributable to air pollution has been a challenge, in part due to uncertainty about human exposure to air pollution worldwide. In large parts of the world air quality measurements are absent or limited to PM_{10} or total suspended particulates from which $PM_{2.5}$ has been estimated. Atmospheric chemistry and transport models have been used to account for other environments, including those for which no measurement data are available.

We present results obtained with an atmospheric chemistry – general circulation model, applied at high resolution to compute global air quality changes, combined with population data, country-level health statistics and pollution exposure response functions. Our calculations of air pollution related mortality follow the method of the GBD for 2010, applying improved exposure response functions that more realistically account for health effects at very high $PM_{2.5}$ concentrations compared to former assessments. We calculate that outdoor air pollution, mostly by $PM_{2.5}$, leads to 3.3 million premature deaths/year worldwide, predominantly in Asia (75 %). We attribute premature mortality to seven source categories, and distinguish urban from rural air pollution. Following the GBD analysis, we primarily assume that all particles are equally toxic, while in a sensitivity study we assume that carbonaceous particles are most harmful.

Contrary to the common view that traffic, industry and power generation are dominant sources, we show that residential energy use (e. g., heating, cooking) is the largest category due to its prevalence in India and China, and would even be predominant by assuming differential toxicity. While in the western world traffic and power generation are important, in the Eastern USA, Europe, Russia and East Asia agricultural emissions make the largest relative contribution to $PM_{2.5}$. Projections based on a business-as-usual scenario indicate that mortality attributable to air pollution could double in the coming decades.

Release of engineered nanoparticles during waste incineration

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ABSTRACT

Nanotechnology is an innovative key technology in Germany, with an approx. turnover of 13 billion € in year 2013. [BMBF 2013]. Its applications are found in the field of electronics and extend to chemistry and pharmacy, in which nanomaterials are used as additives. They are found as innovative material in clothing, cosmetics, coatings, paints and detergents. Analysis that engages with disposal and recycling of these materials are hardly published. [Struwe und Schindler 2012]. In this project, the release of nanoparticles in laboratory and pilot scale as well as in an industrial waste incineration plant is analysed. The main focus of the fundamental experiments is to determine the thermal stability of agglomerated Ceria particles (dp = 60 nm; n = 105 cm^{-3}) in premixed propane flames. The laboratory experiments demonstrate the formation of a new particles with diameters less than 20 nm and a number concentration of 107 cm^{-3}. We hypothesize this indicates evaporation or sublimation of the cerium dioxide particles and recondensation in cooler zones of the flame. These findings are used for the analysis at the pilot incineration plant and in an industrial incineration plant, in which the thermal waste disposal analysis was carried out by injecting cerium dioxide as tracer substance. Results show retention of nanoparticle tracer materials by a factor of up to 10^4 in relation to the injected amount. All mass flows of the industrial incineration plant like boiler slake and waste water were analysed to establish a material balance for the cerium dioxide flows. The results show a recovery rate of more than 80%. The main part was found in the effluent of the scrubbers.

BMBF – Bundesministerium für Bildung und Forschung. nano.DE-Report 2013 Status quo der Nanotechnologie in Deutschland

Struwe, Jutta; Schindler, Eva (2012): Bedeutung von Nanomaterialien beim Recycling von Abfällen. Arbeitspapier 270. With assistance of Oliver Pfirrmann, Elias Kost. Edited by Hans-Böckler-Stiftung.

Keywords: nanoparticle, aerosol, waste incineration, agglomeration

A new portable device for high time resolved measurements of wide range aerosol size distributions

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Grimm Aerosol Technik GmbH & Co. KG, 83404 Ainring, Germany

Keywords: aerosol instruments, Nano particles, particle size distributions, work place measurements

A measurement of particle size distributions for Nano particles and particles in the µ-meter size range generally requires a combination of separated devices as Scanning Mobility Particle Sizers (SMPS) and Optical Particle Counters (OPC) or aerodynamic particle sizers (APS). The GRIMM Company developed a new compact and portable device that consists of an optical and electrical sensor in one device. It allows a wide range of particle size detection between 10 nm and 25 µm with 40 size channels with a time resolution of one complete scan of only 1 minute. Thus, very short-lived as well as highly time-varying particle sources can be examined. Figure 1 shows the new device.

Figure 1: Grimm MINI-WRAS for broad particle size distributions

The measured values of the two sensors are combined internally by a special electronics and firmware, such that the user receives measurements, which do not differ from the output of a single sensor in the nature and structure. The calculation of the derived measures as particle surfaces and particle volumes is done online and the output as data telegram is sent via the interfaces Bluetooth or RS232. Special control software was developed, which allows full operation with a small Netbook. Figure 2 shows a measurement results at workplace.

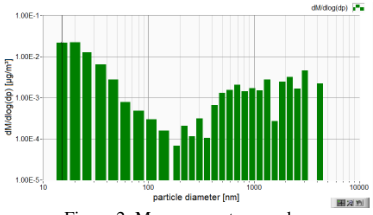

Figure 2: Measurement example

The optical module is a newly designed particle spectrometer, which detects each individual particle and classifies its size accordingly (single particle counting). A powerful laser diode is used as a light source. An internal monitor diode monitors the power of the laser diode and keeps it constant. A pin diode generates the detection signal, which turned out to be the best compromise between reliability and performance. The number of particles is determined by the number of stray light pulses per period, the particle size determines the amplitude of the scattered light. These measurements require a precisely controlled flow rate, which is determined continuously via aperture and pressure sensors.

The electrical module consists of three main components, the unipolar corona charger, a precipitation electrode and a Faraday Cup Electrometer (FCE). Once the aerosol particles (each single particle) are counted by the optical sensor and classified, they go through a short tube connected directly to the electrical sensor. Here all Nanoparticles can be reliably detected. Initially the particles are charged unipolar (negatively) in the electric sensor with a negative corona charge. Then the particles go into a collecting electrode, where they are separated according to their electrical mobility. A portion of the aerosol stream passes through the collecting electrode and is recorded in the Faraday Cup Electrometer (FCE). Based on the current measured at the FCE, the volume flow, the geometry of the sensor and the charge efficiency of the particles, the size of the particles can be determined. The electrical sensor offers the possibility to determine the number of particles of a size distribution of particles similar to the optical sensor: A change of the electrode voltage in 10 steps classifies the particle size between 10 nm to approximately 200 nm in 10 classes.

The calibration and validation is based on parallel SMPS measurements with latex particles of different sizes.

Portable Nanoparticle Instrumentation for Oncoming Motor Vehicle Regulations

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Testo AG, Germany

ABSTRACT

Particle counting on diesel cars is mandatory for type approval through Euro 5b since September 2011 and has been also introduced for GDI vehicles through Euro 6 by September 2014. The European Union and other countries throughout the world will continue to integrate particle counting into their emission standards, especially since the World Health Organization reclassified diesel engine exhaust as 'carcinogenic to humans'. Last September, according to this strategy, the European Commission has proposed particle counting for several categories of internal combustion engines for non-road mobile machinery. Moreover, the Commission is working on the approach for the technical assessment of PEMS for particle number emitted by light-duty vehicles under real world conditions. In Switzerland the periodic control of the construction machinery on field is mandatory since January 2013. As result, the oncoming test procedures for different vehicles categories may include on-road measurements and periodic control of particle emissions requesting suitable technology as an extension of the Particle Measurement Program (PMP).

With an eye on real driving measurements of nanoparticles proposed in forthcoming European Emission Standards and periodic control on the field, Testo AG has unveiled novel portable instrumentation for solid nanoparticle counting and classification. This innovative instrumentation based on Diffusion Size Classifier technology measures number concentration and average diameter in a wide range under real world conditions.

The latest results, published by JRC during the evaluation of the PEMS-PN measurement technology on behalf of the European Commission, highlighted the optimal operability of this technology under real driving conditions and the very good correlation of particle number in comparison with PMP Benchmark systems on the chassis dynamometer.

This presentation aims to show the instrument functionality and the calibration procedure followed by some results from comparisons with traditional aerosol instruments in the laboratory and on-road.

Determination of the filtering effect of airborne particles for a model of flow around a cylinder with a slit

Stanislaw Kaminski[1,2,3], Dorota Kaminska[3]

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2 Polish Committee for Standardization, Technical Committee on Air Quality
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ABSTRACT

Filtering effect of airborne particles may be a result of poor geometry of air sampler (AS) or lack of isokinetic sampling. The ISO 21501-1 standard, that describes the different ways to determine of particles size distribution, draws attention to this effect. Considering the AS shaped in form of cylinder with a slit as a model, an attempt to assess the filtering effect was made.

The paper presents a theoretical model of the ideal flow around a cylinder with the slit. The changes of the Reynolds number from 500 to 100 000 were considered. These changes correspond with a velocity of the flow around from 0.1 m / s to 20 m / s. Velocity and pressure distributions on the surface of the cylinder were identified. A flow conditions in the inner chamber of the cylinder were formulated. The whole discussion was confirmed by qualitative study in a wind tunnel by visualizing the filtering effects on the flow. The illustrations in the form of freeze frame are taken from the videos posted on youtube at www.youtube.com/user/kamikadotpl.

A method of calculating the trajectory of external flow around the cylinder and in the inner chamber of the cylinder is shown for airborne particles regarding the density and dynamic viscosity of the air and the possibility of evaporation of the particles

The filtering effect of the airborne particles due to the different velocities of flow around a cylinder was analyzed both for external velocities as well as for velocities in the inner chamber of the cylinder.

Characterisation of exposure to ultrafine particles at traffic intersections

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ABSTRACT

Accurate estimation of public exposure to ultrafine particles (those below 100 nm in diameter), which consist majority of particle number concentration (PNCs), during commuting is important for epidemiological assessments and developing relevant policies. Even a short period of time spent in conditions with peak PNCs during commuting may contribute to significant proportion of overall exposure (Goel and Kumar, 2014). Objectives of this study were identification of: (i) traffic driving conditions under which peak PNCs occur on roadways, (ii) in–cabin peak PNCs variation with respect to on–road peak PNCs during different ventilation settings, and (iii) the contribution of exposure during peak PNCs condition to overall commuting exposure. Mobile measurements of size–resolved PNCs in 5– 560 nm range were carried out on a 6 km long round route that contained 10 TIs under five different ventilation conditions (Goel and Kumar, 2015). Measurements were taken sequentially inside and outside the car cabin at 10 Hz sampling rate using a solenoid switching system in conjunction with a fast response differential particle spectrometer (DMS50). In most of the instances, peak PNCs were found to occur at congested signalised traffic intersections when vehicle accelerate from stop light. In–cabin peak PNCs followed similar temporal pattern as for on–road peak PNCs. The lag period for this case was 30–60 s for an individual setting (fan on and heating off) and increased to 30–90 s during another settings (fan off and heating on, and both fan and heating off). As small as 2% of total commuting time spent at TIs was found to contribute to ~25% of total exposure during commuting.

References:

Goel, A., Kumar, P., 2014. A review of fundamental drivers governing the emissions, dispersion and exposure to vehicle-emitted nanoparticles at signalised traffic intersections. Atmospheric Environment 97, 316-331.

Goel, A., Kumar, P., 2015. Characterisation of nanoparticle emissions and exposure at traffic intersections through fast-response mobile and sequential measurements (under review).

Personal exposure to ultrafine particles, Black Carbon and $PM_{2.5}$ in different microenvironments

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3 Statistical Consulting Unit, Department of Statistics, Ludwig-Maximilans-University, Munich, Germany

ABSTRACT

Exposure assessment studies have shown that air pollution measured by fixed monitors at residential locations may not adequately represent individual exposures, especially for times spent away from home. In the framework of a study combining individual and central monitoring site measurements we characterized personal exposures in specific micro-environments to particulate air pollutants generated by different sources.

The measurements were done three times for three weeks, in different seasons (winter, spring and summer). The exposure data were collected by a single researcher equipped with personal monitors for continuous measurements of particle number concentration (PNC), black smoke (BS) and $PM_{2.5}$. As pedestrian or passenger in public transportation he was taking the same route including major roads, urban background and industrial areas every day. His position was recorded by a GPS device.

In the winter season the overall average personal exposure to each pollutant was higher than the corresponding ambient levels (39 vs. 27 μgm^{-3} for $PM_{2.5}$, 4.1 vs. 2.8 μgm^{-3} for BS and 21375 vs. 12497 cm^{-3} for PNC). Whereas personal exposure to $PM_{2.5}$ during his walks along busy streets and in a residential area was very similar (41.5 vs. 41.1 μgm^{-3}), there were very pronounced differences regarding PNC and BS (35656 vs. 15369 cm^{-3} and 5.7 vs. 3.3 μgm^{-3}, respectively). Times spent in the bus highly contributed to elevated personal BS levels. At the conference results for all three seasons will be shown.

The obtained results provide insight into the potential air pollution levels to which people could be exposed and will be used in future analyses in addition to data from the fixed monitoring station in order to get more reliable estimates concerning people's total exposure to UFP, BS and $PM_{2.5}$, especially when being in traffic or in a near-road environment. This work has been supported by German Research Foundation DFG Contract Number CY68/1-1.

The Measurement of Ultrafines & Black Carbon in Glasgow City Centre

David Sykes, Ricardo-AEA, Glasgow, United Kingdom

ABSTRACT

A Scottish Government-funded project to determine if there was a relationship between height above the pavement and air quality was conducted in Glasgow City Centre during 2014. Instruments were set at two heights of 0.8 m and 1.68 m and pushed around the city centre on a mobile platform. Measurements were taken for up to 10 hours, over 8 days (sampling was over one or more days per month between March and August) and included particulates, gases, weather and GPS position. Ultrafine particle (UFP) and Black Carbon (BC) measurements were taken using a Philips Nanotracer and a Magee AE51 MicroAeth respectively.

There was evidence of increased pollutant concentrations at the lower height, and in a separate study increased bioaerosol numbers at 0.8 m than at 1.68 m, however this is presented in more detail elsewhere. Despite a range of weather conditions throughout the experiments there was no significant correlation between wind direction or speed and any pollutant.

Spikes in both UFP and BC measurements (as with other pollutants) were noted both during peak traffic times and in particular street canyons with known high pollution. However these spikes only manifest when a moving average of the data was used. Temporal resolution for the instruments measuring both UFP and BC was set to 1 minute intervals, however when comparing BC with UFP using this timeframe correlation was low (R^2 = 0.255), but increased (R^2 = 0.690) when the data was averaged over a 30-minute period. A relationship between these pollutant species has been noted in other studies. Thus, although these instruments can theoretically measure temporal resolutions of one or more seconds, more useful data from this scenario was seen with averaged data and this is and the results are discussed in more detail.

Ultrafine particles and black carbon exposure concentration levels along a pedestrian route

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ABSTRACT

High concentration levels of black carbon (BC) and ultrafine particles (UFP), which have been linked to health problems, are typical for urban environments. In particular, BC is reported to be related to vehicular traffic emissions and is used as a tracer of primary anthropogenic emissions since its variability reflects changes in source strengths and atmospheric mixing characteristics.

Two condensation particle counters and two micro-aethalometers were used for the simultaneous measurement of both UFP and BC while walking along a 17 km urban route and at an urban background sampling site in Milan. The field campaigns were designed in order to investigate the spatial and temporal variability of the personal exposure concentrations. The measurements covered a period from December 2013 through July 2014 with two measurement sessions per day (morning and afternoon) during weekdays; the measurements were occasionally extended also to weekends. The pedestrian route included six different urban zones, each characterized by different traffic intensity and regulation (including the congestion charge area). The comparison of the concentration levels along the pedestrian route with urban background measurements enabled the removal of the meteorological effects on mobile measurements.

For both pollutants the highest mean concentrations were observed in the winter period along traffic exposed sections of the pedestrian route. The trends in UFP number and BC data were very similar and this is reflected in the high correlation in the exposure levels between the two pollutants in these traffic exposed sections. UFP and BC mean concentrations observed along the pedestrian route were higher than at the urban background site, suggesting that the concentrations measured at fixed monitoring stations may be a poor indicator of the real exposure. The congestion charge effect on air quality was more visible on BC than on UFP.

Monitoring of UFP concentration and size distribution at four urban background sites in NW-Europe

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ABSTRACT

Within the Joaquin project, ultrafine particles (UFP) are continuously measured at one urban background location in four cities in NW-Europe (Amsterdam, Antwerp, Leicester and London). The main aims are to investigate the temporal variation in UFP number concentration and size distribution, to assess the added value of UFP data in addition to more common parameters such as nitrogen oxides (NOx) and black carbon (BC) and to evaluate the feasibility of long-term UFP measurements within air quality monitoring networks. At all sites the total particle number concentration (PNC) was measured with a condensation particle counter (TSI-3783, particles < 1 µm) and BC with a MAAP (Thermo-5012). Information on the particle size distribution was obtained by a scanning mobility particle sizer (Grimm-5420/LDMA) in Amsterdam and Antwerp and by a differential mobility analyzer with corona discharger and electrometer (TSI-3031) in Leicester and London.

To assess instrument comparability, there was an initial measurement campaign in Antwerp and follow-up comparisons at the four sites using a mobile trailer. The agreement between devices of the same type was good (<10% difference), but the total PNC was underestimated by the size-resolved devices compared with the particle counters. Results will be presented based on 1–2 years of measurements, depending on the site. UFP, BC and NO_2 showed a clear traffic-related diurnal variation with morning and evening rush hour peaks on weekdays, but only a clear evening peak in the weekends. The relative distribution of particles in 5 size classes from 20 to 200 nm was quite similar at all sites, with the highest particle number in the 30–50 nm class. BC and NO_2 were correlated with the total and size-specific PNC, but the relationships depended on the site, probably reflecting differences in local site and traffic characteristics.

Acknowledgment: this work is supported by the Interreg IVB North-West Europe programme.

Near one kilometer vertical profiles of ultrafine particles over the city of Barcelona

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ABSTRACT

The vertical distribution of ultrafine (UFP) and micronic particles across and above the planetary boundary layer over the Mediterranean urban environment of Barcelona was investigated. Measurements were carried out using a tethered balloon equipped with a miniaturized condensation particle counter (CPC), a miniaturized optical particle counter (OPC), a micro-aethalometer, a rotating impactor, meteorological instrumentation and a GPS. Vertical profiles up to 980 m a.s.l. were studied between 8:00 and 16:00 local time. Simultaneous measurements on aerosol levels, size and composition, ambient gaseous pollutants concentrations and meteorological parameters were also carried out at a ground urban location and at a regional background site 40 km far from Barcelona. Nucleation events were observed during two days of the campaign. Both events were initiated in the urban area, i.e., the precursors were emitted by the city and urban photochemically-activated nucleation occurred both at high atmospheric levels (tens to hundreds of metres) and at ground level. The nucleation at ground level was limited by the high particulate matter concentrations recorded during the morning traffic rush hours that increase the condensation sink preventing nucleation. Therefore nucleation at ground level was restricted to midday and early afternoon. The aloft nucleation occurred earlier as the thermally ascending polluted air mass was diluted. The event affected the regional background only from midday and early afternoon when sea and mountain breezes transported the urban air mass towards the regional background site after particle growth. These events are different from the usual ones described in literature, characterized by a regionally originated nucleation, driven both by photochemistry and an increase of precursors concentrations, starting early in the morning in the regional background with a subsequent growth. We elaborated an idealized and simplified model of the spatial and time occurrence of these two types of nucleation episodes into, around (regional background) and over the city.

KEYWORDS: ultrafine aerosols, planetary boundary layer, nucleation, tethered balloon, new particle formation
ACKNOWLEDGEMENTS: This work was funded by the European LIFE+ AIRUSE project (LIFE11 ENV/ES/584), the Spanish Ministry of Agriculture, Food and the Environment (UCA2009020083), the Generalitat de Catalunya (AGAUR 2015 SGR33 and the DGQA) and the Korea Ministry of Environment through "The Eco-Innovation project". The authors are grateful to the Real Club de Polo de Barcelona and the Ajuntament de Barcelona.

Ultrafine Particle and Black Carbon measurements at an urban background site: a multi-technique monitoring approach

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ABSTRACT

Black Carbon (BC) and ultrafine particles (UFPs) have been recently attracting great attention for the related impacts on atmospheric processes and for their adverse effects on human health; nevertheless, both BC and UFP are still not considered in the frame of air quality standards. In urban areas UFP number concentration and related size distribution, and BC data can profitably trace the activity of combustion sources, namely fresh traffic emissions and diesel engine exhaust. To this purpose the employment of high time-resolved measurements can offer great advantages if compared to pollutant criteria considered for air quality assessment.

This work reports the results of collocated UFP counter and BC measurements at an urban background site in Milan during February 2014. A multi-technique approach is here proposed in order to obtain a more complete characterization of the atmospheric aerosol. Size-resolved particle number concentration data in 6 size intervals in the 20-1000 nm range are collected by means of a TSI 3031 UFP monitor. Carbonaceous nanoparticles are measured by using a home-made instrument based on Laser-Induced Incandescence (LII) technique, which is proved to be a powerful optical tool for carbonaceous particle concentration and particle diameter. This instrument is optically calibrated to obtain quantitative data without the employment of other techniques. For comparison, AE51 one-wavelength Aethalometer data are also used to obtain BC concentration from light absorption. In order to measure size segregated chemical composition of submicron particles, AMS data are also collected. All measurements are taken at high time resolution (10-min average), enabling to track the diurnal pattern of the concentration levels.

The different kind of information gathered on carbon particles are compared and correlations among data obtained through the different techniques are presented. Moreover, the relations between size-resolved particle number concentrations and carbonaceous species is also investigated and discussed.

Monitoring black carbon concentrations with mobile devices in the city of Liège

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ABSTRACT

The use of portable devices to evaluate atmospheric pollution is getting more and more common. These instruments, often based on an electrochemical or an optoelectronic sensor, not only allow for high time resolution measurements, they also probably herald the future of air quality monitoring.

In the framework of the ExTraCar project, AethLabs AE51 analyzers are used along with GlobalSat DG-200 GPS loggers to localize hot spots of black carbon (BC) concentrations in the heart of Liège, a city of about 200,000 inhabitants in the eastern part of Belgium. For this campaign, up to sixoperators walk or bike simultaneously along pre-defined tracks. The latter were chosen to illustrate contrasted situations, both in terms of emissions, e.g. a busy street vs a park, and dispersion conditions, e.g.the valley bottom vs the hilltop. These measurement sessions started inApril 2014 and will last until January 2016; they are mainly made during rush hours but some additional experiments are also scheduled to evaluate pollution levels during off-peak hours.

If collecting data with a 1-s time step in an urban environment is interesting, using these records is a somewhat more challenging task, for the GPS raw data may suffer from a lack of accuracy while the BC analyzer raw data may suffer from a lack of precision. Procedures have been developed to solve these problems and make the data set appropriate for further analysis and modelling.
In this presentation, we describe our measurement campaign, including the maintenance planning, then we explain the data processing and, finally, we show our web GIS application and some analytical results.

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