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

# Ultrafine Particles – Air Quality and Climate

Brussels, Belgium
July 5 and 6, 2022

Ultrafine particles (UFP), the nano fraction of airborne particulate matter, are considered to be causing serious health problems and environmental effects. Combustion is a major source, also by producing volatile organic pollutants which are converted in the atmosphere through photochemical reactions.

Increasing applications of man-made nanomaterials add to the problem, e.g. after incineration at the end of their lifetime. A further interest in UFP's results from their specific 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 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 on particulate matter, 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 8th Ultrafine Particles Symposium 2022 will again feature the most recent scientific progress in the field and so contribute to policy-relevant developments which 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 to contribute actively and hope to see you again at the State representation of Baden-Württemberg in Brussels in July, 2022.

Thomas Leisner | Chairman

## Tuesday, 5 July

### Opening Plenary

10:00 Representative of the State of Baden-Württemberg / Bodo Lehmann
EFCA President / Andrzej Jagusiewicz
Symposium Chairman / Thomas Leisner

### Keynotes – Session A

10:30 – 11:15 | Europasaal
Session Chair: Thomas Leisner

10:30 **Plastic air pollution – what do we know?**
Stephanie Wright
Imperial College London, United Kingdom



### Session B – UFP Sources

11:15 – 12:35 | Europasaal
Session Chair: Andreas Meyer

11:15 B.1
**UFP monitoring campaigns at London Heathrow Airport**
Brian Stacey
Ricardo Energy & Environment, Harwell, Oxon, United Kingdom

11:35 B.2
**Shipping as an aggressive sector of Ultrafine Particles (UfP) emissions**
Andrzej Jagusiewicz
President of EFCA, Poland

11:55 B.3
**Variability of Airborne Ultrafine Particles in Number and Size within the Urban Neighbourhoods Close to a Major European Airport**
Julius Seidler
University of Bayreuth, Germany

12:15 B.4
**On-board measurement of ultrafine non-exhaust particulate emissions from a battery electric vehicle**
Linda Bondorf
German Aerospace Center (DLR), Stuttgart, Germany

12:35 Lunch

### Keynote Session C

13:35 – 14:20 | Europasaal
Session Chair: Thomas Leisner

13:35 **Ultrafine aerosol particles in the atmosphere: instrumentation and results**
Tuukka Petäjä
University of Helsinki, Finland

## Session D – Methods

14:20 – 15:40 | Europasaal
Session Chair: Harald Saathoff

14:20 D.1
**Physico-chemical characterization and source apportionment of UFP at airport, harbour, subway and road: the nPETS experimental set-up in Barcelona**
Sharon Ridolfo
IDAEA, Barcelona, Spain

14:40 D.2
**Nanofiltration must be combined with laminar vertical flow to minimize Virus infection risk**
Andreas Mayer
NanoCleanAir GmbH CEO, Niederrohrdorf, Switzerland

15:00 D.3
**Method Optimization and Physico-chemical characterisation of UFPs**
Deeksha Shukla
Helmholtz Zentrum München (HMGU), Germany

15:20 D.4
**Method, equipment and exemplary results for harmonized UFP number and size distribution measurements following CEN/TS 16976 and CEN/TS 17434**
Torsten Tritscher
TSI GmbH, Aachen, Germany

15:40 Coffee Break

## Session E – Urban Aerosols I

16:00 – 17:40 | Europasaal
Session Chair: Ranka Godec

16:00 E.1
**Equivalent BC properties during the COVID-19 spring 2020 lockdown period in Brussels, Belgium compared to non-lockdown periods**
Alexander Mangold
Royal Meteorological Institute of Belgium,
Brussels, Belgium

16:20 E.2
**Research Infrastructure's to evaluate advanced air quality parameters, including ultrafine particles, in urban Europe (RI-URBANS)**
Xavier Querol
Institute of Environmental Assessment and Water Research (IDÆA), Barcelona, Spain

16:40 E.3
**Source apportionment of Black carbon (BC) particles in urban background in European cities in the frame of the RI-URBANS project**
Marjan Savadkoohi
Institute of Environmental Assessment and
Water Research (IDÆA), Spain

17:00 E.4
**Chemical characterization and source apportionment of PM2.5 in two East-Mediterranean sites**
Marc Fadel
Université du Littoral Cote d'Opale,
Dunkirk, France

17:20 E.5
**Representing UFP urban background concentrations with the chemistry-transport model LOTOS-EUROS**
Astrid Manders
TNO, Utrecht, The Netherlands

## Poster Session F & Buffet

17:40 – 19:30 | Foyer/Patio

F.1 **Comparison of carbon mass concentrations in PM2.5 and PM1.0**
Ranka Godec
Institute for medical research and occupational health, Zagreb, Croatia

F.2 **Relationship between chemical composition, source apportionment and oxidative potential of PM2.5 in an East-Mediterranean site**
Dominique Courcot
University of Littoral Cote d'Opale,
Dunkirk (ULCO), France

F.3 **Evaluation of air quality changes in a Chinese megacity over 2006 – 2021 using PM2.5 receptor modelling**
Anna Canals Angerri
Institute of Environmental Assessment and
Water Research (IDAEA-CSIC), Barcelona, Spain

F.4 **Mass concentration of water-soluble ions in PM2.5 at a coastal urban background site in Croatia**
Valentina Gluščić
Institute for Medical Research and Occupational Health, Zagreb, Croatia

F.5 **Determining the influence of material structure and sizing on the comminution behaviour of carbon fibres**
Jonathan Mahl
Karlsruhe Institute of Technology,
Karlsruhe, Germany

F.6 **The Investigated of Relative Variable Importance (RVI) and Strength of Interaction Effects (SIE) of fine-Particlesand variables during Movement Control Order condition by using the Stochastic Boosted Regression Treestechnique.**
Noor Yahaya
Universiti Malaysia Teerengganu, Malaysia

F.7 **Accounting PM Emissions in Life Cycle Assessment LCA**
Peter Brantsch, Thomas Reichert,
Fraunhofer ICT, Pfinztal, Germany

F.8 **A closer look at the invisible – unprecedented levels of ultrafine particles (UFP) and the hydrological cycle**
Wolfgang Junkermann
Karsruhe Institute of Technology, Germany

F.9 **Laboratory and on-road tests assessment of fine and ultrafine particle emission factors for Euro 6LPG passenger cars**
Giovanni Lonati
Politecnico di Milano, Italy

F.10 **Impact of Ultrafine Particle Emissions from In-land Ferries**
Sina Acksen
Helmholtz-Zentrum Geesthacht, Germany

## EXHIBITORS

Envicontrol – environmental technologies

TSI GmbH

Grimm Aerosol Technik

www.clean-aviation.eu

AAVOS Environmental & Process Analysers

## Wednesday, 6 July

### Keynotes – Session G

09:00 – 09:45 | Europasaal
Session Chair: Thomas Leisner

09:00 **Spatial Distribution of Combustion Related Ultrafeine Particles in Innsbruck, Austria**
Armin Hansel
University of Innsbruck, Austria

### Keynotes – Session H

09:45 – 10:30 | Europasaal
Session Chair: Thomas Leisner

09:45 **Exposure to iron-rich pollution nanoparticles: a specific risk to human brains and hearts?**
Barbara Maher
University of Lancaster, United Kingdom

10:30 Coffee Break

### Session I – Urban Aerosols II

10:45 – 12:25 | Europasaal
Session Chair: Xavier Querol

10:45 I.1
**Carcinogenic organic compounds in PM1 particle fraction at an urban location with "canyon" effect**
Ivana Jakovljević,
Institute for Medical Research and Occupational Health, Zagreb, Croatia

11:05 I.2
**Levels of carbohydrates in PM1 particulate matter emitted during wintertime**
Suzana Sopčić
Institute for Medical Research and Occupational Health, Zagreb, Croatia

11:25 I.3
**Tuning sampling and analysis strategies for UFP: Laboratory and field tests with selected PAH-marker components**
Elisabeth Eckenberger
University of Bayreuth, Germany

11:45 I.4
**Spatial and temporal variation of ultrafine particles in the Bavarian centres of the NAKO health study: Augsburg and Regensburg**
Josef Cyrys
Helmholtz Zentrum München (HMGU), Germany

12:05 I.5
**Characterisation of inhalable aerosols from carbon fibres**
Sonja Mülhopt
Karlsruhe Institute of Technology,
Karlsruhe, Germany

12:25 Lunch

## Session J – Health Effects

13:25 – 14:45 | Europasaal
Session Chair: Flemming Cassee

13:25 J.1
**Relationships between oxidative potential of PM size, composition & source apportionment in urban & regional background in Barcelona, NE Spain**
Marten in-t Veld
Institute of Environmental Assessment and Water Research (IDÆA), Barcelona, Spain

13:45 J.2
**Validation of an Aerosol Exposure Air-Liquid-Interface (AE-ALI) system to facilitate more realistic hazard identification of nano-sized aerosol exposure in human relevant culture models**
Chang Guo
CRCE, UK Health Security Agency (UKHSA, previously called PHE), Oxfordshire, United Kingdom

14:05 J.3
**Functional Effects of Carbon Black Nanoparticles on Primary Airway Epithelial Cells in vitro**
Totta Ehret Kasemo
University Clinic Würzburg, Germany

14:25 J.4
**Short term and long term exposure to UFP of Schiphol Amsterdam airport**
Flemming R. Cassee
RIVM, The Netherlands

14:45 Coffee Break



## Panel Discussion
## From monitoring to measures – How to transfer science into societal and administrative action

15:00 – 16:30
Session Chair: Karl-Friedrich Ziegahn

**Armin Hansel**
University of Innsbruck, Austria

**Barbara Maher**
University of Lancaster, United Kingdom

**Tuukka Petäjä**
University of Helsinki, Finland

**Stephanie Wright**
Imperial College London, United Kingdom

## Statement

"Air pollution is one of the greatest environmental risks to public health."

"In recent years, ultrafine particles have been recognized as crucial because of their ability to reach the most distal lung regions and greatly impact the cardiovascular system."

"A reduction of coal combustion, and other policy actions, can account for a noticeable decrease of gaseous and PM levels, and for a drastic reduction of metals in ambient air."

"The identification of emission sources is of utmost importance to policymakers in order to implement policies to protect health and improve the air quality in the region."

"The determination of health effects directly related to UFP as well as determination of emission sources and standardized emission monitoring is essential for successful air quality measures incorporating airborne UFP.

## Symposium Chairman

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

## Organizing Committee

**Sabine Aref**
Gesellschaft für Umweltsimulation (GUS)

**Susanne Bolz**
Karlsruhe Institute of Technology (KIT)

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KIT Climate and Environment Center

**Klara Langer**
Karlsruhe Institute of Technology (KIT)

**Thomas Reichert**
Fraunhofer ICT, EFCA and CEEES

**Angela Richter**
Helmholtz Gemeinschaft, Brussels Office

**Harald Saathoff**
Karlsruhe Institute of Technology (KIT)

## Proceedings

Presentations and Posters will be published electronically after the Symposium.

**Jean Guy Bartaire,** APPA, France

**Abdurrahman Bayram,** TUNCAP, Turkey

**John Bynorth,** EPS, Scotland

**Giulio D'Emilia,** CEEES, Italy

**Giuseppe Fumarola,** COSRIA/ATI, Italy

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**Rudolf Neuroth,** KRdL in VDI and DIN, Germany

**Marianne Popp,** Institute for Ecology and Conservation Biology, BOKU, Vienna, Austria

**Andrea von Känel,** Cercl'Air, Switzerland

**Karl-Friedrich Ziegahn,** KIT and GUS, Germany

**Urs Baltensperger,** Paul Scherrer Institut, Villingen PSI, Switzerland

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**Manfred Neuberger,** Institute for Environmental Hygiene, Medical University of Vienna, Austria

**Gordana Pehnec,** CAPPA, Croatia

**Xavier Querol,** Consejo Superior de Investigaciones Científicas CSIC, Barcelona, Spain

**Claire Segala,** SEPIA, Paris, France

**Rachel Smith,** Nanotoxicology Research Centre, Oxfordshire, United Kingdom

**Ulrich Teipel,** Technische Hochschule Nürnberg, Germany

**Bernhard Vogel,** Institute for Meteorology and Climate Research, KIT, Germany

**Marion Wichmann-Fiebig,** Federal Environmental Agency, Dessau-Roßlau, Gemany





Presentation

## Plastic air pollution – what do we know?

Dr Stephanie Wright, Lecturer of Environmental Toxicology

Environmental Research Group, MRC Centre for Environment and Health, School of Public Health, Imperial College London, UK

### ABSTRACT

Micro- and nanoscopic plastic debris ('microplastic'), originating through the degradation of plastic materials, is ubiquitous in the environment. Laboratory studies indicate that exposure to high levels of microplastic can negatively impact biota following exposure, primarily via oxidative stress and metabolic disruption. Recently, microplastic has been reported in atmospheric deposition and airmasses around the globe, suggesting a complex network of environmental pathways before it reaches its environmental – or biological – fate. Furthermore, the discovery of microplastic in ambient and indoor air has raised concern for public exposure via inhalation and potential impacts on health. However, there are critical physicochemical factors which govern the fate and effects of inhaled microplastic material in the body. Very little is known about atmospheric microplastic pollution, and this is partly due to the analytical challenge they present.

In this talk, I will give an overview of the progress in plastic aerosol research. I will present my Team's research, from early environmental measurements to analytical and data science advances. It will highlight knowledge gaps and recommend key research areas. As plastic production and use continues to grow, it is timely to establish baseline knowledge of global airborne microplastic burdens and to begin to understand if and what their potential role in disease pathways might be.

Bio: Dr Stephanie Wright is a Rutherford Fellow and Lecturer in Environmental Toxicology in the Medical Research Council Centre for Environment and Health, Imperial College London. She completed a B.Sc Hons 1.1 (Newcastle University), then a PhD in Biosciences at the University of Exeter (2015), which focused on the toxicity of microplastics in the marine environment. Through two fellowships, she has established her field in microplastics and human health. Specifically, Dr Wright's team advances analytical and data science approaches to quantify external and internal micro- and nanoplastic exposure, in complement to assessing their adverse outcomes in vitro. She has participated in working groups for the World Health Organisation and the European Commission and is on the editorial board for the journal Microplastics and Nanoplastics (Springer).

Presentation

## UFP monitoring campaigns at London Heathrow Airport

Brian Stacey
Knowledge Leader, Air Quality Measurements
Ricardo Energy & Environment
Gemini Building, Fermi Avenue, Harwell, Oxon, OX11 0QR, UK
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### ABSTRACT

Very high concentrations of ultrafine particles were measured at London Heathrow Airport. Exposure to UFP is strongly linked to adverse health effects and guidance for exposure limits has recently been provided by the World Health Organization (WHO). Using very high time resolution UFP measurements and aircraft GPS data, measurements were assigned to individual aircraft and their operating mode, and this information was used to model UFP emissions. In all cases, highest emissions were associated with departing aircraft, with larger aircraft emitting more than smaller aircraft. Emissions per passenger is influenced by the number of passengers carried, especially for arriving aircraft. Calculated emission rates are significantly higher than stated literature values, as condensable particles are also included in the measurements. Measured UFP concentrations inside the airport perimeter exceed the WHO guidance, indicating that assessing population exposure around airports will be of increasing importance in future.





Presentation

## Shipping as an aggressive sector of Ultrafine Particles (UfP) emissions

PhD Andrzej Jagusiewicz, President of EFCA (European Federation of Clean Air and Environmental Protection Associations)

### ABSTRACT

Daily, cruise ships worldwide emit as much particular matter as a million of cars and a single large vessel emit over five tonnes of nitrogen oxides (NOx) and 450 kg of ultrafine particles (UfP) into the air during the operating day. And in terms of greenhouse gases emissions (GHG) data show that cruising emits almost four times more carbon dioxide (CO2) per passenger than flying. Shipping is responsible for a large part of UfP both as primary and secondary pollutants.

However, much serious environmental impact comes from international ship transport which accounts for 80 % of global trade volume. The world's merchant fleet is composed of almost 100.000 ships, of which 70 % are oil tankers and 13 % container ships. Its total marine fuel consumption, made from the dirtiest dregs of the barrel, is estimated for more than 300 Mt, and grows constantly. In terms of emissions maritime transport emits annually around billion tons of carbon dioxide, but statistically, international shipping is responsible for less than 3 % of global climate forcer emissions annually.

Worse is with classic pollutants, including of course UfPs and their precursors, where shipping is responsible on average for 25 % of the nitrogen oxide emissions (NOx) and 9% of the sulphur oxides emissions (SOx). As much as 70% of all ship emissions occur along heavily frequented trading routes connecting ports and are less than 400 km from the land. But they can be easily transported hundreds of kilometres onshore and contribute not only to the local pollution, but also transboundary one. Also important is that 85% of all ship pollution is in the northern hemisphere, the geographical area of UNECE and its Air Convention, unfortunately not yet a global one.

The main sources of emissions from ships are uncontrolled or only poorly controlled combustion in all types of on-board boilers and of all types of fuels. Their complete review is given in the work to assess information on emission abatement technologies for the reduction of air pollutant emissions, from shipping activities carried out within the ongoing revision of the Revised Gothenburg Protocol. The remediation measures of technical nature are well known as they are strictly applied since long for the same emission sources on land. Among them let's mention better fuel containing less sulphur, flue gas desulphurization systems (FGD), selective catalytic reduction (SCR) lowering NOx emissions and particles filters in first instance.

But as well important are the spatial planning measures called SECA for "Sulphur Emissions Control Areas" and "NECA for "NOx Emissions Control Areas" along the coasts defined and established with the frame of the International Convention for the Prevention of Pollution from Ships (MARPOL). This is the global treaty as shipping is per excellence a global business. They oblige the ship operators to emit less pollutants when entering such emission control areas.

And finally, the administrative measure as speed limit called in case "slow steaming" as well as greening of port activities and investing into pro-environmental structure are completing the scope of remediation action.

Concerning policy options to control ship emissions we can so far rely on the outcome of the EFCA session on emissions from shipping held at Croatian Scientific and Professional Conference in Medulin (Istria) in mid of September 2021 calling in the first instance for synergy between IMO and its MARPOL Convention, the EU Directives, and the Protocols of the UN/ECE Air Convention and for including into the Amended Gothenburg Protocol a new Annex on control techniques for ship/shipping emissions. The expected decision can come at the 42nd session of the Executive Body (EB) in December 2022. Also, the Global Forum for international cooperation on air pollution led by Sweden and the United Kingdom and Northern Ireland launched officially at the last EB session in December 2021 may easily include ships/shipping and recommend further control measures.

Presentation

## Variability of Airborne Ultrafine Particles in Number and Size within the Urban Neighbourhoods Close to a Major European Airport.

Seidler, Julius[a,b], julius.seidler@uni-bayreuth.de / +49 921/55-5724
Friedrich, Markus[a,b], Vogel, Alexander[d], Thomas, Christoph[a,c], Nölscher, Anke[a,b]

[a] University of Bayreuth, Bayreuth Center of Ecology and Environmental Research (BayCEER)
[b] Atmospheric Chemistry
[c] Micrometeorology
[d] Goethe-University Frankfurt, Institute for Atmospheric and Environmental Sciences

### ABSTRACT

During the past two decades multiple studies highlighted the possible contribution of airports to atmospheric ultrafine particles (UFP) next to other anthropogenic and natural sources. UFP are in the size range of 100 nm or less and can be either liquid or solid. When airborne, UFP can have multiple effects on climate, weather and air quality i.e. when impacting cloud formation as condensation nuclei, altering chemical processes in the atmosphere, or being aspirated or taken up. Here, we aim to investigate to what extent a major airport contributes to the overall atmospheric UFP mixture in the surrounding neighbourhoods. Our study further elucidates the real-world UFP mixture including air traffic, airport facilities, associated near-ground traffic, and adjacent urban and biogenic UFP sources.

Therefore we designed and established two monitoring stations on a North-South axis to Munich Airport, with a station-to-runway distance of 2 and 2.5 km. Both stations are equipped for continuously measuring UFP by means of a mobility particle size spectrometer (MPSS, 8...800 nm). A total condensation particle counter (CPC, 8...3000 nm) is used for reference and quality control. The setup is completed by meteorological measurements (wind speed and direction, precipitation, solar radiation, humidity, pressure and temperature) which are crucial parameters for exploring transport and mixing processes.

Deployed during Summer 2021, we will present as first results time series of UFP number size distributions and how they are connected to atmospheric conditions, wind speed and direction in particular as well as airport operation and other emission sectors in the surroundings. This project is funded by the Bavarian State Ministry of the Environment and Consumer Protection (TLK01U-76519).





Presentation

## On-board measurement of ultrafine non-exhaust particulate emissions from a battery electric vehicle

Linda Bondorf[1], Tobias Grein[1], Lennart Köhler[2], Franz Phillips[2], Tobias Schripp[1]

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[2] Institute of Vehicle Concepts, German Aerospace Center (DLR), Stuttgart, 70569, Germany

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### ABSTRACT

Non-exhaust particle emissions already dominate the European transport sector (OECD, 2020). The chemical composition of airborne brake and tire wear particles indicates increased environmental and health risks (Amato, 2018). Knowledge of the quantity and size distribution of the emitted particles is essential for hazard assessment and reduction. Standardized tests use component test bench measurements to determine brake and tire emissions. Although these offer comparable results, the test conditions differ strongly from those on the vehicle. The objective of this study is to determine and characterize the ultrafine particle emissions from a battery electric car under realistic conditions.

The experiment was performed with a BMW i3, equipped with measuring instruments and a customized sampling setup. This includes a separate encapsulation of brakes and tires which enables direct source allocation. An adjustable ventilation with pre-filtered air is set based on a real drive scenario without modifications and, thus, ensures realistic brake temperatures. Real driving experiments were performed in the area of Stuttgart under different traffic conditions (urban, rural, highway). Additional tests with braking patterns and cornering scenarios were performed on a test site.

The particle measurement instrumentation is connected to an isokinetic sampling at the back of the brake or tire housing. Total particle number concentration between 4 nm and 3 µm is measured by a TSI Condensation Particle Counter. A combination of an Engine Exhaust Particle Sizer (TSI) and an Optical Particle Sizer (TSI) determine the real-time particle size distribution between 5.6 nm and 10 µm. Monitoring the background concentration with a second Condensation Particle Counter enables the identification of particles emitted in the semi-closed tire housing.

Real driving tests show a strong dependence of non-exhaust emissions on driving conditions. Braking emissions occur despite recuperation and are highest at high speeds. Tire emissions depend primarily on longitudinal and lateral vehicle acceleration.
Acknowledgment: This work was carried out as part of the ZEDU-1 (Zero Emission Drive Unit – Generation 1) project and is supported by the Baden-Württemberg Ministry of Economics, Labour and Housing.

**References:**

Amato, F., 2018. Non-Exhaust Emissions An Urban Air Quality Problem for Public Health;
Impact and Mitigation Measures. OECD, 2020. Non-exhaust Particulate Emissions from Road Transport.

Presentation

## Ultrafine aerosol particles in the atmosphere: instrumentation and results

Tuukka Petäjä, Institute for Atmospheric and Earth System Research (INAR) / Physics, Faculty of Science, University of Helsinki, Finland

### ABSTRACT

Atmospheric aerosol number concentration is dominated by ultrafine aerosol particles, i.e. particles smaller than 100 nm in diameter. Sources of aerosol number are either primary emissions from combustion processes or secondary aerosol production. In the nanometer size range, delayed primary emissions also contribute to the number concentration in the vicinity of traffic.

Determining ambient aerosol number concentration is highly sensitive technological parameters, such as instrumental performance, instrument calibration and sampling losses as well as atmospheric features, such as ambient aerosol size distribution, distance from emission sources and atmospheric chemistry, physics and meteorogy that determine secondary aerosol formation processes.

In this presentation I will introduce the challenge of aerosol number size distribution measurements down to 1 nm in size, consequences of sampling location and selected instrumentation with selected example data sets from Europe. I will also discuss the need for harmonized aerosol size distribution measurements as well as a concept of hierarchical observation network to accomplish a more comprehensive view on the urban air quality. Finally, I will briefly introduce on-going pilot activities performed in different European cities in the framework of RI-URBANS research project.





Presentation

## Physico-chemical characterization and source apportionment of UFP at airport, harbour, subway and road: the nPETS experimental set-up in Barcelona

S. Ridolfo[1]*, A. Karanasiou[1], X. Querol[1], A. Alastuey[1], B. van Drooge[1], U. Olofsson[2], E. Bergseth[2], E. Carbonell[3], J. Vila[4], J. Cortes[4], M. Pedrero[5], M. Madrid[5], I. Hernandez[6], and F. Amato[1]

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[5] AENA SME, S.A. - Josep Tarradellas Barcelona-El Prat Airport, 08820 El Prat de Llobregat, Barcelona, Spain
[6] Department of Climate Action, Food and Rural Agenda of the Governement of Catalonia, 08036 Barcelona, Spain.

Keywords: nanoparticles, airport, harbour, road traffic, chemical characterization

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### ABSTRACT

The nPETS (Nanoparticle Emissions From The Transport Sector) is a H2020 project (grant agreement No 954377) started in June 2021 that aims to develop new knowledge in transport generated non-regulated sub 100 nm particle emissions. The project involves partners from several European cities (Barcelona, Stockholm, Milan and Thessaloniki) and includes measurements of ultrafine particles (UFP) and their effects on living cells from different transport sources (https://www.npets-project.eu/).

Within the three years of the project, UFP monitoring and sampling in Spain include five different monitoring sites (urban background, kerbside, airport and harbour in Barcelona and subway in Valencia). Two measurement campaigns (cold and warm season) with the same methodology will be carried out at each site with a mobile laboratory van, with one month duration each. Instrumentation at the urban background, airport, harbour and kerbside include ELPI+ electric impactor, two DGI impactors, SMPS, CPC for particle diameter >2.5nm, multi-wavelengths aethalometer, PM1 chemical speciation (for ions, elements, OC and EC, Querol et al, 2001) and NOx, SO2, CO and O3 analysers, while subway platform measurements will include ELPI+ and DGIs. At the airport and harbour sites, a second instrumented van will be used in parallel for upwind SMPS measurements.

In all the campaigns, the size-segregated samples from the ELPI+ and of the DGIs will be used to determine major and trace elements by means of ICP-AES and ICP-MS respectively, while the back-up UFP filter of one DGI will be used for organic chemistry speciation. Shorter measurements will also be carried out with impactors for each sampling site for SEM and TEM analysis.

Size distribution data from ELPI+ and Particle Number Size Distribution from 2.5 nm will be analyzed with the PMF multivariate analysis method (Rivas, 2020) for source apportionment.

This work shows details of the methodological approach and preliminary results of the physico-chemical characterization of UFP at different types of urban environments.

**Bibliography**

Querol X. et al. (2001), Atmospheric Environment, 35 (36), 6407-6419.
Rivas I. et al. (2020), Environment International 135, 105345.

Presentation

## Nanofiltration must be combined with laminar vertical flow to minimize Virus infection risk.

Dipl.Ing. Dr.med.h.c.A.Mayer[1], Dr.ing.J.Mayer[1], Prof.Dr.H.Burtscher[5], Prof.Dr.J.Czerwinski[1], Dipl.Ing.ETH Th.Lutz[1], MS. R.Mayer[1]; Prof.Dr.B.Rothen[2]; Prof.em.Dr.J.Frey[3]; Dr.Chr.Lämmle[4],

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### ABSTRACT

A new ceramic multicell filter has been developed with > 1 m2 per liter bulk volume reaching > 99% efficiency for solid particles of 10-500 nm for petrol engines which do not build up a soot cake.

To test the bioaerosol filtration properties of these filters a research program was set up with the universities Bern and Fribourg, using bacteriophages MS2 as surrogate for SARS-CoV-2, a virus which is even smaller and does not provide any risk to human. This virus, which is commercially available in a water suspension, was emitted as a spray into a clean air channel, perfectly distributed and dried to its naked size of 30-40 nm. The best pore size configuration of the experimental wall flow filters did in fact reach a filtration rate of 99.9999 % for these bacteriophages and the deactiva-tion test of deposited virus resulted in < 1% after 48 hrs.

This filter was used for a novel ventilation system of a class room. The ventilation was designed to exchange the air volume of the room five times per hour. Contaminated air was extracted at the ceiling by 40 m of porous tubes and recycled after filtration to the bottom corners, again using porous tubes. $CO_2$-controlled fresh air from outside was also filtered to clean it from traffic ultrafine particles.

The dynamic cleaning process and room distribution was tested with salt nanoparticles simulating the virus source by a cloud concentration of 80'000 particles per cubic centimeter [P/cc]. The cross contamination reaching the neighbour of the infected schoolboy contained only 2-300 P/cc, de-monstrating that the contaminated air escapes vertically, showing a reduction of the infection risk of >2 orders of magnitude. The Particle distribution was very uniform in the entire room within a few percent variation. Half life for cleaning a contaminated room was 8 minutes, finally reaching a level far below roadside ambient air and the particle concentration downstream of the filter was be-low detection limit of the DC-particle counters. This unque virus cleaning system, a product of Na-noCleanAir GmbH is universally applicable also for hospitals, elevator cabins, aircraft cabins, buses, trains.





Presentation

## Method Optimization and Physico-chemical characterisation of UFPs

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### ABSTRACT

Ultrafine Particles (UFP) pose a possible risk to human health because of their small particle size and their ability to penetrate deep into the lungs and to translocate to essential organs. Previous research has found a strong link between chemical composition and biological response to UFPs, which can cause oxidative stress by producing large levels of reactive oxygen species (Yuan et al., 2019). However, analysing the chemical composition can be challenging, especially for the small mass of UFPs.

Our focus is on optimizing the sampling and analysis strategies for comprehensive characterisation of the organic composition of airborne UFPs by using Direct Thermal Desorption (DTD) two-dimensional gas chromatography (GC×GC) coupled with mass spectrometry. We present a method that can separate and detect the semi volatile organic fraction at molecular levels according to their polarity and volatility providing information about the molecular structure of particle bound components. We will implement in-situ derivatisation techniques with the advantage of no need of previous extraction and easy automation.

Therefore, we are coupling a modified MOUDI impactor (cut-off 100 nm) with a sequential filter sampler (Partisol 2025, Thermo Scientific). First experiments with a sampling flow of 30 L min-1 for 24 hours in a rural sampling site were conducted and our method was able to determine PAH, o-PAH and the alkylated PAH in the lower picograms levels. We found noteworthy concentrations of Benzo[a]pyrene (75 pg m-3) and Dibenzo[ah]anthracene (3.8 pg m-3) in comparison to the target value of 1 ng/m³ which is typically determined for PM2.5 or PM10 (directive 2004/107/EC). Now we propose to quantify OAs in femtogram levels, because we want to further improve the sharpness of the cut-off (break-through of larger particles could result in huge impact on found concentration) and reduce the sampling period for achieving higher time resolution.

This project is financed by the Bavarian Ministry of the Environment and Consumer Protection.

**Reference**

Yuan, Y., Wu, Y., Ge, X., Nie, D., Wang, M., Zhou, H., & Chen, M. (2019). In vitro toxicity evaluation of heavy metals in urban air particulate matter on human lung epithelial cells. Science of the Total Environment, 678, 301-308.

Presentation

## METHOD, EQUIPMENT AND EXEMPLARY RESULTS FOR HARMONIZED UFP NUMBER AND SIZE DISTRIBUTION MEASUREMENTS FOLLOWING CEN/TS 16976 AND CEN/TS 17434

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### ABSTRACT

For many years, mass-based particulate matter PM2.5 and PM10 measurements have been standardized and represented the cornerstone for the regulatory quantification and characterization of particles in ambient air. In the past decade the measurement of ultrafine particles (UFP) has gained importance outside the field of atmospheric research. Studies like the one by de Jesus et al. (2019) have highlighted the world-wide need to address UFP concentrations due to their potential risks for human health. UFP particle number concentrations (PN) and particle number size distributions (PSD) have been measured by scientifically motivated projects and networks (e.g. ACTRIS, GAW, GUAN) for years (Birmili et al. 2016). However, comparing the results can be difficult when different instruments and sampling setups are used.

In an effort to harmonize the continuous measurement of UFP in terms of their PN and PSD in ambient air, the European Committee for Standardization (CEN) published technical specifications CEN/TS 16976 for Condensation Particle Counters (CPC) and CEN/TS 17434 for Mobility Particle Size Spectrometer (MPSS) or Scanning Mobility Particle Sizer (SMPS). These normative documents describe a standardized method by defining a set of requirements for the instrument, its sampling system, the measurement procedure and the reporting of measurement results.

We will introduce the recent customization of our established CPC and SMPS instruments with dedicated sampling and dilution options to meet these CEN/TS specifications. We will show results from several weeks of ambient measurement of the urban aerosol in a light industrial area in Aachen, Germany. A full-flow butanol-based CPC (Model 3750-CEN, TSI Inc., Shoreview, USA) is calibrated independently at the World Calibration Center for Aerosol Physics (WCCAP) in Leipzig, in addition to the manufacturer's calibration. The same is done for the new wide-range SMPS (Model 3938W50-CEN, TSI Inc.), so it fully complies with the CEN/TS 17434 guideline. An optimized sampling inlet system with dryer, RH/T control and an optional diluter were used to enable standardized measurements. A further advantage of this complete UFP monitoring solution is its comprehensive data output, which permits a transfer to the EBAS database and other data protocols.

Birmili, W., Weinhold, K., Rasch, F., et al. Long-term observations of tropospheric particle number size distributions and equivalent black carbon mass concentrations in the German Ultrafine Aerosol Network (GUAN). Earth Syst. Sci. Data (2016)
CEN/TS 16976. Ambient air - Determination of the particle number concentration of atmospheric aerosol, published August, 2016.
CEN/TS 17434. Ambient air - Determination of the particle number size distribution of atmospheric aerosol using a Mobility Particle Size Spectrometer (MPSS), published June, 2020.
de Jesus, A.L., Rahman, M.M., Mazaheri, M., et al. Ultrafine particles and PM2.5 in the air of cities around the world: Are they representative of each other? Environ. Intern. (2019)





Presentation

## Equivalent BC properties during the COVID-19 spring 2020 lockdown period in Brussels, Belgium compared to non-lockdown periods

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### ABSTRACT

A relevant part of (ultra-)fine particles in the urban atmosphere are light-absorbing particles. Important sources for such particles are emissions from traffic and from domestic heating. During the COVID-19 strict lockdown in Belgium, in spring 2020, traffic and public life was distinctly restricted. It is of interest what has been the impact of these measures. The Royal Meteorological Institute of Belgium in Brussels operates an aethalometer since 2014 (absorption coefficient and mass concentration of light-absorbing aerosol, or 'equivalent Black Carbon; 'eq-BC'). The measurement site is located in the sub-urban, southern part of Brussels.

The mass concentration of eq-BC shows a typical annual cycle with higher values in winter than in summer and a typical daily cycle with clear peaks during rush hour times and in the early evening. During the lockdown period values for the mass concentration of eq-BC were distinctly lower compared to former years and revealed a less pronounced daily cycle. The Absorption Angstrom Exponent (AAE; spectral dependency of the absorption coefficient) is exploited to derive the relative contribution of fresh soot (thus traffic emissions) and other sources to the amount of light-absorbing aerosol. During the COVID-19 lockdown period, the AAE values were distinctly higher compared to the other years, indicating that traffic emissions decreased in overall importance and absorbing aerosol from other sources gained in importance.

It remains, however, difficult to assign these effects purely to the lockdown measures. There is an overall decreasing tendency of the mass concentration of equivalent BC over the former years and also during the transit period from winter to spring. In addition, the meteorological conditions have a substantial influence on the concentrations. Respective results, including the atmospheric stability, mixing layer height and wind will be presented and discussed.

## TUESDAY, 5 JULY | EUROPASAAL

10:00 – 10:30
**Opening**

10:30 – 11:15
**Keynote Session A**

11:15 – 12:35
**Session B – UFP Sources**

**Lunch**
FOYER/PATIO

13:35 – 14:20
**Keynote Session C**

14:20 – 15:40
**Session D – Methods**

**Coffee Break**
FOYER

16:00 – 17:40
**Session E – Urban Aerosols I**

17:40 – 19:30
**Poster Session F & Buffet**
FOYER/PATIO

## WEDNESDAY, 6 JULY | EUROPASAAL

09:00 – 09:45
**Keynote Session G**

09:45 – 10:30
**Keynote Session H**

**Coffee Break**
FOYER

10:45 – 12:25
**Session I – Urban Aerosols II**

**Lunch**
FOYER/PATIO

13:25 – 14:45
**Session J – Health Effects**

**Coffee Break**
FOYER

15:00 – 16:30
**Panel Discussion –**
**From Monitoring to Measures**

Presentation

## Research Infrastructure's to evaluate advanced air quality parameters, including ultrafine particles, in urban Europe (RI-URBANS)

Xavier Querol[1], Tuukka Petäjä[2], Pedro Trechera[1], Andrés Alastuey[1], André Prevot[3]
(on behalf of the RI-URBANS partners)

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[3] Paul Scherrer Institute (PSI), Villigen, Switzerland

### ABSTRACT

RI-URBANS is a large EC-H2020 funded Project (grant agreement 101036245) to demonstrate how Service Tools (STs) from atmospheric Research Infrastructures (RIs) can be adapted and enhanced to provide advanced air quality (AQ) measurements in European cities and industrial, harbour, airport and road traffic hotspots, as well as areas with significant levels of air pollution and associated health effects. RI-URBANS combines advanced scientific knowledge and innovative technical work to develop pilot STs that will enhance the capacity of the AQMNs to provide the necessary observations to evaluate, predict and abate urban air pollution. We will deploy tools and information systems in the hands of citizens and communities to support decision making by AQ managers and regulators. RI-URBANS focuses on human exposure to outdoor ambient ultrafine particles (UFP, levels and particle size distribution, PSD) and atmospheric particulate matter (PM, in mass concentration) in terms of their sizes and constituents, as well as their source contributions and gaseous precursors (including VOCs and NH3). We compile available data on urban UFP-PSD and BC, among others, in Europe; we evaluate the health outcomes using these datasets; we elaborate STs that are being tested/demonstrated in 5 pilot studies in 12 cities; and finally we suggest a route for upscaling these STs across urban Europe. In this presentation we report on the RI-URBANS activities and will show data from the UFP-PSD data compilation in urban Europe.





Presentation

## Source apportionment of Black carbon (BC) particles in urban background in European cities in the frame of the RI-URBANS project

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Keywords: Ultrafine particles, Black carbon, Source apportionment, Air quality monitoring, RI-URBANS.

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### ABSTRACT

The RI-URBAN project focuses on human exposure to outdoor ambient ultrafine (UFP) particles and particulate matter (PM) concentrations with special attention paid to the role that the sources of these atmospheric constituents have on human health. One specific objective is to interpret and reveal the benefit of obtaining datasets from urban sites on novel air quality metrics, as UFP and black carbon (BC), and their source contributions.

In this study, a long-term database of concentrations of eBC measured in around 20 European cities used to evaluate the use of BC as a measurement parameter in pollution control networks. The database was created using data available in the ACTRIS Network and also by contacting European cities to collect BC concentration data not included in ACTRIS. These cities are characterized by different meteorological conditions and emissions. Available eBC concentrations were measured with Aethalometers (AE33) and multi-angle absorption photometers (MAAP) in the selected urban environments. The contribution of eBC from fossil fuel (BCFF) and wood-burning (BCWB) sources is estimated based on the absorption coefficients of aerosol particles at seven different wavelengths measured by the AE33.

Here we present an in-depth BC source contribution analysis obtained by applying the bilinear model presented by Sandradewi et al. (2008) to AE33 data. We evaluate the model results obtained using both the widely used absorption Angstrom exponents (AAE) of 1 (AAEff) and 2 (AAEwb) for fossil and non-fossil sources, respectively, and the site-dependent AAEff and AAEwb determined from the experimental data. These latter were obtained by studying the frequency distributions of experimental AAE obtained at each urban site. In addition, the temporal and spatial variability of the MAC will be studied by comparing the measurements of absorption from AE33 and MAAP and of EC concentrations performed at the selected cities.

This work was supported by the European Commission for "European Research Infrastructures capacities and services to address European Green Deal challenges (LC-GD-9-1-2020) under grant PRE2020-095498.

Presentation

## Chemical characterization and source apportionment of PM2.5 in two East-Mediterranean sites

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Keywords: PM2.5, chemical speciation, sources contribution, urban-industrial sites, East-Mediterranean region.

### ABSTRACT

The East Mediterranean region faces elevated concentrations of PM resulting from transported pollution mixed with anthropogenic emissions (traffic, industrial, and residential emissions), and natural emissions (Saharan and African deserts) [1]. It is considered as a hotspot of climate change where model projections show elevated temperatures by the end of the century leading to the increase of photochemical air pollution [2]. Therefore, it is crucial to determine the sources of pollution in the region in order to develop efficient air quality strategies. PM2.5 samples were collected on a 24-hour basis every third day for a year in two urban sites under industrial influence in Lebanon: Zouk Mikael region (ZK) and Fiaa region (FA). ZK is characterized by the biggest power plant in the country which runs on heavy fuel oil, a high density of population (4,200 inhabitants/km2) along with high road traffic and the use of diesel generators for electricity generation. FA is surrounded by chemical industries such as the cement plants along with their corresponding quarries. The samples were characterized for their carbonaceous fraction, water-soluble ions, elements, and organic species (alkanes, PAHs, fatty acids, biogenic secondary organic aerosols, etc.). Several species and tracer compounds were gathered in the USEPA-PMF model in order to assess the contribution of the sources to the PM2.5 concentrations. Crustal dust and secondary ammonium sulfate contributed to 43% and 46% of PM2.5 at ZK and FA. These sources mainly originate from long range transport of air masses as evaluated by HYSPLIT cluster analysis of air mass back-trajectories. Vehicular and industrial emissions were two important sources at ZK contributing to 14% and 13% of PM2.5, respectively. While at FA, vehicular and cement plants emissions contribute together to 13%. Furthermore, open burning of waste explained 16% of PM2.5 concentration at FA. Primary and secondary biogenic emissions contributed to 9% of PM2.5 at ZK and 13% at FA. This study is a first in Lebanon and from the few in the region using extensive dataset on PM2.5 chemical composition with organic and inorganic species and quantifying the contribution of different natural and anthropogenic sources.
This work was supported by the National Council for Scientific Research of Lebanon, Faculty of Sciences and the Research Council at Saint Joseph University of Beirut -Lebanon, and the "Unité de Chimie Environnementale et Interactions sur le Vivant" (UCEIV-UR4492) of "Université du Littoral Côte d'Opale", Dunkirk-France. This work has been also produced within the framework of the EMME-CARE project.

**References**

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Presentation

## Representing UFP urban background concentrations with the chemistry-transport model LOTOS-EUROS

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### ABSTRACT

Exposure assessment for ultrafine particle (UFP) is a challenge since the representation of UFP in space and time is currently insufficient. Although toxicological studies point at the harmful effects, it is difficult to show effect in cohort studies. In addition, UFP can come from several sources and disentangling their contributions can be relevant for both health studies and for policy making. UFP concentrations have strong gradients close to the source, but particle losses due to coagulation and deposition are often not included in local dispersion models. In addition, emissions are relatively uncertain. For regional-scale models, the correct representation of the smallest, most abundant nucleation mode particles is challenging, along with the uncertainties in the emissions, their size distribution and composition.

We coupled the sectional aerosol model SALSA2 (Kokkola et al , 2018) to the regional-scale chemistry transport LOTOS-EUROS (Manders et al, 2017) with the aim to model city background levels on a resolution of the order of 1 km. We will present results for an application over Berlin for 2019. The approach and results will be discussed in the light of emissions (available datasets, volatile/nonvolatile, size distributions), representation of regional-scale nucleation events (nesting or boundary conditions from measurements), validation and relation to conventionally modelled air pollutants (BC, NOx, PM2.5).

Poster

## Comparison of carbon mass concentrations in $PM_{2.5}$ and $PM_{1.0}$

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### ABSTRACT

This investigation aimed to compare the ambient air concentrations of $PM_{2.5}$ and $PM_{1.0}$ particle fractions, as well as the particle-bound carbon mass concentrations and carbon content in each particle fraction. The study was conducted within the internal scientific project "Organic content of $PM_1$ particle fraction" funded by the Institute for Medical Research and Occupational Health (PI: R. Godec). During a three-year period (2018-2020), daily samples of airborne particles were collected on pre-fired quartz fiber filters at the northern, residential part of the city of Zagreb, where the main sources of particle matter (PM) and carbon species are mostly household appliances and moderate traffic. The nominal sampling flow rate was 38 dm³/min.

PM mass concentrations were determined gravimetrically following the European norm EN 12341:2014. Samples were analyzed for organic carbon (OC) and elemental carbon (EC) using the thermal/optical transmittance method (TOT) with the EUSAAR_2 protocol following the European norm EN 16909:2017. During the measurement period, average PM mass concentrations were 12.9 µg/m³ and 17.0 µg/m³ for $PM_{1.0}$ and $PM_{2.5}$, respectively, while the mass concentrations of EC and OC were 0.76 µg/m³ and 4.55 µg/m³ in $PM_{1.0}$ and 1.03 µg/m³ and 5.42 µg/m³ in the $PM_{2.5}$ particle fraction. Annual mass concentrations of PM, OC, and TC (total carbon) in both particle fractions followed the sequence: 2018 > 2020 > 2019, while EC in $PM_{1.0}$ and $PM_{2.5}$ followed the sequence: 2020 > 2018 >2019. The average EC/OC mass ratio was higher in the $PM_{1.0}$ than in the $PM_{2.5}$ particle fraction. The annual average EC/OC mass ratio in both fractions was higher than 3, suggesting the presence of SOA (secondary organic aerosol) and were in the order: 2018 > 2019 >2020.

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Poster

## Relationship between chemical composition, source apportionment and oxidative potential of PM2.5 in an East-Mediterranean site

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Keywords: PM2.5, oxidative potential, source apportionment, East-Mediterranean region.

### ABSTRACT

Among the different air pollutants, PM2.5 can be easily inhaled into the lungs and might cause diverse health effects especially cardiovascular and respiratory diseases [1]. That is why it is important to understand which species contribute the most to the toxicity of these particles. One of the practical indicators recently used for the evaluation of the oxidative capacity of PM as whole is the oxidative potential (OP) [2]. In this study, the oxidative potential of PM2.5 was evaluated using dithiothreitol (DTT) and ascorbic acid (AA) assays on samples collected in an urban site under industrial influence in the East Mediterranean: Zouk Mikael region (ZK) in Lebanon. ZK is characterized by the biggest power plant in the country which runs on heavy fuel oil, a high density of population (4,200 inhabitants/km2) along with high road traffic and the use of diesel generators for electricity generation. The mean volume normalized OP-AAv value was 0.67 ± 0.29 nmol.min-1.m-3. On the other hand, the mean OP-DTTv was 0.52 ± 0.32 nmol.min-1.m-3. Different approaches were used to study the relationship between the characterized species (carbonaceous matter, ions, major and trace elements, and organic compounds) or the sources contribution and OP values. Spearman correlations and hierarchical classification after principal components analysis showed that both OP-DTTv and OP-AAv were correlated with species emitted from HFO combustion, diesel generators, crustal dust, road dust and vehicular emissions sources. A multiple linear regression approach was applied to the contribution of the sources obtained by PMF and the OP values. The results showed that the sources that largely contribute to the PM2.5 mass (crustal dust and ammonium sulfate sources) were not the major sources contributing to the values of OP. However, local anthropogenic sources such as biomass burning (33% of OP-AAv and 9% of OP-DTTv), vehicular emissions (20% and 23%), and heavy fuel oil combustion (31% and 46%) contribute the most to the OP-AAv and OP-DTTv, respectively. This study is a first in Lebanon and in the East Mediterranean and the Middle Eastern region presenting results of oxidative potential (OP-AA and OP-DTT). The findings of this study will be of utmost importance to policymakers in order to implement policies to protect health and improve the air quality in the region.
This work was supported by the National Council for Scientific Research of Lebanon, Faculty of Sciences and the Research Council at Saint Joseph University of Beirut -Lebanon, and the "Unité de Chimie Environnementale et Interactions sur le Vivant" (UCEIV-UR4492) of "Université du Littoral Côte d'Opale", Dunkirk-France. This work has been also produced within the framework of the EMME-CARE project.

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Poster

## Evaluation of air quality changes in a Chinese megacity over 2006 – 2021 using $PM_{2.5}$ receptor modelling

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### ABSTRACT

Research of air quality parameters is key to better characterize its impacts on air pollution, human health, and climate. Particulate matter (PM) concentrations are variable due to multiple emission sources and meteorological conditions. China experienced a substantial increase of the $PM_{2.5}$ concentrations from 2000 to 2013, however after the application of restrictive measures a sharp decrease was recorded (Geng et al., 2021). This study focuses on the major $PM_{2.5}$ changes and source contributions in Wuhan (P.R. China) from 2006 to 2021, using receptor modelling and experimental $PM_{2.5}$ speciation.

High-volume $PM_{2.5}$ sampling was carried out at different urban and industrial background sites in metropolitan Wuhan. Following the analysis of the samples, receptor modelling tools were applied for datasets from 2006-2007 and 2019-2021. Ancillary data on $SO_2$, $NO_2$, $PM_{2.5}$, $PM_{10}$ and CO concentrations and meteorological parameters were supplied by the Wuhan Eco-Environmental Protection Bureau.

As a result of the implementation of air quality protection policies and actions, results evidenced a decrease of average $PM_{2.5}$ levels of -65%, -88% for $SO_2$ attributable to the decrease of coal combustion, and -25% $NO_2$ reduction attributable to the effect of the policy counter-rested by the increase of vehicles. Other reductions were exposed such as relative contributions to $PM_{2.5}$ (-48 to -71%), coal-combustion (-76 to -90%) and traffic (-22 to -54%) related elements and $NO_3^-$ (-22%). Secondary inorganic aerosol (SIA) main component differs from a 77% $(NH_4)_2SO_4$ to 52% $NH_4NO_3$ from 2006 to 2021. Toxic organic tracers reach relatively low concentrations, in the range of generally accepted ones.

The marked reduction of coal combustion, and other policy actions, accounted for a noticeable decrease of gaseous and PM levels, and for a drastic reduction of metals in ambient air. The contributions to all those from road transport and domestic/residential/commercial sources, decreased also but in a much lesser extent.





Poster

## MASS CONCENTRATIONS OF WATER-SOLUBLE IONS IN PM2.5 AT A COASTAL URBAN BACKGROUND SITE IN CROATIA

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### ABSTRACT

The aim of this study was to examine the five-year trend of $PM_{2.5}$ mass concentrations and mass concentrations of water soluble inorganic ions ($Cl^-$, $NO_3^-$, $SO_4^{2-}$, $Na^+$, $NH_4^+$, $K^+$, $Mg^{2+}$, $Ca^{2+}$) in its content. Daily $PM_{2.5}$ samples were collected on Teflon and Quartz fibre filters from 2017 to 2021 at an urban background station in Croatia. Mass concentrations of $PM_{2.5}$ were determined gravimetrically according to the standard HRN EN 12341:2014 (EN 12341:2014). The content of water-soluble inorganic anions and cations was determined by ion chromatography according to HRI CEN/TR 16269:2017 and HRN EN 16913:2017 (EN 16913:2017). Results showed that the annual average PM2.5 mass concentrations ranged from 7.6 μg $m^{-3}$ to 10.9 μg $m^{-3}$. The annual average mass concentrations of anions and cations ranged from 0.01 μg $m^{-3}$ to 2.6 μg $m^{-3}$, while the contribution to the overall $PM_{2.5}$ mass ranged from 27.9% to 37.3%. During the five-year period of measurement, the observed $PM_{2.5}$ mass concentrations as well as mass concentrations of water-soluble ions showed a decreasing trend. Also, the annual average equivalent ratio between the sum of all anions and the sum of all cations was calculated in order to evaluate the balance between the determined ionic compounds and possible acidic fine particulate matter properties. Also, during each year in the five-year period, the $NO_3^-$/$SO_4^{2-}$ ratio was below 1, which suggests a higher contribution of stationary emission sources to air pollution at the coastal urban background station.

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Poster

## Determining the influence of material structure and sizing on the comminution behaviour of carbon fibres

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Keywords: carbon fibres, comminution, fibre analysis

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### ABSTRACT

With the steadily increasing demand for carbon fibres (CF) and carbon fibre reinforced plastics (CFRP), the amount of CFRP waste to be recycled at the end of life is rising. Essential for all optional recycling processes is the homogeneous and reproducible comminution of CF, as well as the knowledge of the dependencies of the comminution behaviour on the material properties of the CF.

For this purpose, an evaluation routine was developed, consisting of a sample preparation of the milled CF, image generation by optical digital microscopy, automatic image analysis and data post processing. This allows the automatic evaluation of up to 15,000 objects per sample and their categorization according to particles (length (L)/diameter (D) < 3), fibres (L/D > 3) and WHO fibres (L/D > 3; L ≥ 5 µm; D ≤ 3 µm), using automatic image analysis software FibreShape (IST AG, Switzerland).

In this study three different CF based on polyacrylonitrile and one based on mesophase pitch were crushed in a planetary ball mill at selected specific energy inputs while varying the speed and the treatment duration, and the comminution behaviour was compared with the mechanical fibre properties. In another series of tests, the same CF were pyrolyzed prior to mechanical grinding to determine the influence of sizing on the comminution behaviour of the CF.

The tests showed that the influence of the sizing on the comminution behaviour of CF is significantly greater than that of tensile strength and Young's modulus. It should be mentioned that respirable fibre fragments were generated in all comminution tests, which should be taken into account with regard to health hazards in the mechanical treatment of CF.

In further studies, additional CF will be investigated with respect to their mechanical comminution behaviour, using further analytical methods.





Poster

## The Investigated of Relative Variable Importance (RVI) and Strength of Interaction Effects (SIE) of fine Particles and variables during Movement Control Order condition by using the Stochastic Boosted Regression Trees technique

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Keywords: Boosted Regression Tree , Relative Variable Importance , Strength of I nteractions Effects

### ABSTRACT

This paper investigated the impact of the COVID 19 Movement Control Order (to the Relative Variable Importance (RVI) and the Strength of Interaction E ffects (SIE) of air pollution concentrations by using the stochastic boosted regression trees (BRT) in selected cities in Malaysia. The one hour calendar year of 8760 data were gathered from the Department of Environment starting from January until December in 2019 and 2020 comprised of fine particles, gases (Nitrogen oxides, Sulphur Dioxide, Ozone, Carbon Monoxide) concentrations and meteorological data (wind speed, wind directions, temperature, and relative humidity) were captured and analysed by using the BRT technique. Model were develop ed by using a using an extended R Software version 4.1. 3 and its packages to understand the variability and model developments. This technique introduces randomness into the boosted model, typically increases the accuracy and speed, and reduces overfitting. A BRT models with different num bers of trees (from 1000 to 10000) were simulated to the datasets with nt = 10000, lr = 0.001 tc = 5, and CV fold = 10. It was found that the relationship between the number of samples and number of trees ( nt) of 4372 for oob were found the best iterations obtained. The performance of the boosting model was assessed and found that the FAC2 was 0.91, the R 2 values were above 0.56 (R = 0.74), and the Index of Agreements (IOA) was 0.67, which are within an acceptable for model performance. Results from one station found that carbon monoxide and ozone were found the most influential parameter or RVI to PM2.5 at Tasek station, in City of Ipoh, Perak for 2019 data with RVI of 47.08% and 25.33% respectively, however, in 2020 instead of ozone, nitrogen dioxide is one of the parameters with highest relative influence alongside carbon monoxide with RVI of 22.76% and 14.95% respective ly.

Keywords : Relative Variable Importance (RVI) RVI), Strength of Interaction Effects (SIE) SIE), Boosted Regression Trees, Air Pollution, Covid 19

Poster

# Accounting PM Emissions in Life Cycle Assessment LCA

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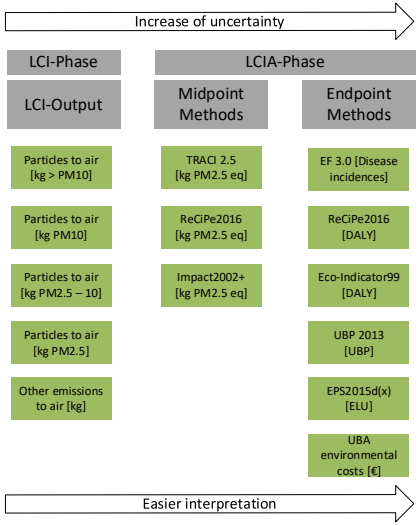
## ABSTRACT

Environmental impacts can be evaluated with Life Cycle Assessment (LCA). Besides the impacts from global warming potential, emissions from Particulate Matter (PM) 10 µm and smaller are strongly related to health issues[1] or socio-economic impacts[2]. The results for PM from Life Cycle Inventory (LCI) are dependent on a full implementation of elementary flows connected with characterization factors to PM and resulting endpoint indicators. Secondary PM are formed from gaseous precursors which need to be considered within methods. Different methods for accounting PM impacts exist and rely on modelled cause and effect chains. Further improvements of existing methods and models for accounting PM impacts are still under development[3],[4].

This poster presentation provides an overview about the accounting methods of PM within LCA and some deeper look into different Life Cycle Impact Assessment (LCIA) methods linked to PM. The poster presentation is raising the question if and how ultrafines can be evaluated within the LCA framework.




| Legend | |
|---|---|
| TRACI | Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts |
| ReCiPe | A "recipe" for calculation of LCIA indicators |
| EF | Environmental Footprint |
| DALY | Disability-Adjusted Life Years |
| UBP – [UBP] | Ecological Scarcity Method – with the unit of eco-points per unit of quantity |
| EPS | Environmental Priority Strategies |
| ELU | Environmental Load Units |
| UBA | German Environment Agency (Umweltbundesamt) |

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Poster

# A closer look at the invisible: Unprecedented levels of ultrafine particles and the hydrological cycle

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## ABSTRACT

Continental as well as maritime ultrafine particles as cloud condensation nuclei (CCN) are likely initially produced by gas to particle conversion starting with nucleation mode aerosol and slowly (within several hours) growing into CCN sizes. Although these birth and growing processes were well investigated since about 50 years, the source locations, where the anthropogenic fraction of these particles are preferably formed still remain uncertain as well as the strength of individual natural or anthropogenic sources.

We present an analysis based on two decades of airborne studies of number and size distribution measurements across Europe, Australia, Mexico and China on nucleation and Aitken mode particles serving as CCN or their precursors. Selected flight patterns allow source apportionment and even a quantitative estimate of emission rates for typical major sources.

Contrary to current global climate model RCP assumptions with decreasing aerosol from 2005 towards the end of the century trends of ultrafine particles and CCN are no longer correlated to sulphur emissions within the last two decades. Nowadays nitrogen and ammonia chemistry is becoming increasingly important for global particle number concentrations. Due to their impact on the hydrological cycle, changes like a slowdown of raindrop production, an increased latent heat flux into the lower free troposphere, an invigoration of torrential rains and a larger water vapour column density might be the consequences. Such recently observed weather patterns are well in agreement with current observations of regional UFP/CCN concentrations and their timely evolution.

Poster

## Laboratory and on-road tests assessment of fine and ultrafine particle emission factors for Euro 6LPG passenger cars

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### ABSTRACT

Exhaust emissions of particulate matter for five Euro 6 bi-fuel (gasoline-LPG) passenger cars were measured during laboratory and on road tests. Small and medium segment cars from different manufacturers, both equipped with retrofit LPG powertrain and with original equipment manufacturer LPG powertrain, were selected in order to represent the Italian circulating fleet of Euro 6 bi-fuel passenger cars.

Laboratory tests were carried out driving the cars on a chassis dynamometer according to different driving cycles. Regulatory particulate matter mass (PM) and solid particle number (PN-PMP compliant) were measured; additionally, soot was measured through a micro soot sensor, PN in the 0.007-10 µm and 5.6-560 nm range through an electrical low pressure impactor (PN-ELPI) and an engine exhaust particle sizer (PN-EEPS), respectively. On road tests were carried in and around the city of Milan in compliance with real drive emission (RDE) regulation, covering a distance of about 73 km. PN measurements were performed by a Portable Emissions Measurement System (PEMS) through a volatile particle remover followed by a diffusion charger detector.

Emissions factors were separately calculated for gasoline and LPG fuelling and compared; related particle size distributions were analyzed. All the regulated emissions were compliant with the Euro 6 limits, except for PN of the only direct injection (DI) engine tested car with gasoline fuelling, which exceeded the limit both in laboratory and on road. In laboratory tests, very low PM emissions were measured for all the cars and for both the fuels, with no statistically significant variations between fuels. Conversely, LPG fuelling resulted in some significant reductions of PN-PMP compliant emissions for most cars over the different driving cycles; significant reductions with LPG fuelling were detected both for non-regulatory PN-ELPI and for PN-EEPS too. Soot emissions were very low with both fuels and generally lower with LPG but statistically significant only for the DI car. On road tests confirmed the results of bench tests, with an indicative reduction (up to 70%) of PN emission switching from gasoline to LPG fuelling.

Keywords: LPG; Emission factors; Passenger cars; Laboratory tests; Real Driving Emissions





## Impact of Ultrafine Particle Emissions from In-land Ferries

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### ABSTRACT

Air pollution by aerosol particles is mainly monitored as particulate matter concentrations like PM2.5 and PM10. However, mass-based measurements are hardly representative for ultrafine particles (UFP), which can only be monitored adequately in terms of particle number (PN) concentrations. Ultrafine particles are of particular concern for human health. Due to their small size, UFP are able to penetrate deeply into the lungs, enter the bloodstream and translocate to other organs of the human body. Number concentrations are a better metric for monitoring ship emission impacts because ship plumes can be better discriminated from the background pollution on the basis of particle numbers. This study examines the impact of in-land passenger ferries by city-scale modelling of PN concentrations and comparing modelled concentrations to localized measurements of ultrafine particle concentrations.

The city-scale chemical transport model EPISODE-CityChem (Karl et al., 2019) is applied to simulate PN concentrations in the urban atmosphere of Hamburg, Germany, with a horizontal resolution of 100 m at surface level. In addition to modelling, monitoring using a TSI P-Trak Ultrafine Particle Counter was performed during a two-week field campaign in winter 2021. Emission inventories for particle number and emission size spectra for different emission sectors influencing concentrations in the city-centre were created, explicitly considering passenger ferryboat traffic as an additional emission source. Emissions from oceangoing ships were calculated using the ship emission model MoSES (Modular Ship Emission Modeling System) (Schwarzkopf et. al.2021). Data from the Automatic Identification System (AIS) was used to determine the fuel consumption based on their movement. Road traffic emissions of exhaust UFP are related to the NOx emission factor of vehicular traffic. Residential heating emissions were calculated based on the population tables of the EU Copernicus Urban Atlas 2012 and heating type information for Hamburg. The background concentrations were based on a 3-month average of size-resolved PN measurement data at Wedel, 20 km to the west of the city centre of Hamburg.

Modelled hourly UFP concentrations were in the range of 10000 - 25000 #/cm3 at a ferry pier, with particle sizes predominantly below 50 nm. The average contribution of ferryboat emissions to modelled UFP concentrations was 21% at a ferry pier station, 4% at a road traffic station and <0.1% at stations in the urban background (Lauenburg et al., 2022). Regularly operating in-land passenger ferries are a significant source of UFP near the Elbe River, affecting densely populated urban areas. Future model simulations should cover longer periods to better understand the influence of meteorological conditions on UFP dynamics in cities.

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Presentation

## Spatial Distribution of Combustion Related Ultrafine Particles in Innsbruck, Austria

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### ABSTRACT

The air quality in urban areas is usually measured at a few stations. This approach allows for a very accurate but only locally valid determination of pollutants such as ozone, NOx (NO + $NO_2$) or particulate matter ($PM_{10}$ and $PM_{2.5}$). While a point measurement of $PM_{10}$ might be representative for the fine particle distribution in a whole city, ultrafine particles (UFP; particles with a diameter smaller than 100 nm) are distributed quite differently. The number concentration of UFP is dominated by local sources, which are mainly traffic-related in a city. Modern combustion engines, which are not equipped with special particle filters, emit a large number of UFPs whose surfaces are loaded with toxic compounds. UFPs have a short lifetime of minutes before they are lost through coagulation with larger particles. High UFP number concentrations are therefore only found in the immediate vicinity of their sources. The UFP exposure of a cyclist can be assessed by the Lung Deposition Surface Area (LDSA). UFP penetrate deep into the lungs and are deposited efficiently in the alveoli.

In this study we investigated the spatial distribution of LDSA values in the Innsbruck area. The measurements took place from December 2017 to December 2018. More than 2000 km were covered on a bicycle equipped with an Partector, a GPS and a GoPro. The same streets were often covered at different times of the day and under different meteorological conditions throughout the year. In addition, on some days the particle size distribution from 10 to 1000 nm was recorded near the highway and in the city in summer and winter.

Results demonstrate, that the spatial extend of "hot spots" strongly depends on weather conditions. Under foehn conditions, high levels of pollution can only be observed at very short distances from their emission sources (busy street crossings). In high-pressure weather conditions, these hot spots are spatially far more extended.





Presentation

## Metal-bearing air pollution nanoparticles in the human brain; possible links with Alzheimer's disease

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### ABSTRACT

Metal-bearing particulates of nanoscale dimensions (< ~ 100 nm) occur in abundance in urban air pollution, especially at major roadways, through vehicle emissions, particularly brakewear. Iron-rich, and strongly magnetic nanoparticles are very abundant in vehiclerelated emissions. Iron (and ferrimagnetic magnetite) can have potentially large impacts on the brain due to a unique combination of redox activity, surface charge and strongly magnetic behaviour. Previous work has shown the presence of magnetite and other Fe oxides, together with metallic Fe and Cu nanoparticles, directly associated with Alzheimer's disease (AD) plaques in human brains. We have used magnetometry, high-resolution transmission electron microscopy (HRTEM), electron energy loss spectroscopy (EELS) and energy dispersive x ray analysis (EDX) to examine the mineralogy, morphology, and composition of magnetic nanoparticles in and from human brain samples (fresh/frozen), from subjects who lived in Mexico City and in Manchester, U.K.. These analyses identified the abundant presence in the brain of magnetite nanoparticles that are consistent with high-temperature formation, suggesting therefore an external, not internal, source. These brain magnetite particles, often found with other, 'exotic' (i.e., non-physiological) metal species, display rounded morphologies and fused surface textures, reflecting condensation from an initially heated, iron-bearing source material. Such high-temperature magnetite 'nanospheres' are ubiquitous and abundant in airborne particulate matter (PM) pollution.

Because of their combination of ultrafine size, specific brain toxicity, and ubiquity within airborne PM, exposure to air pollution-derived magnetite and co-associated metal-bearing nanoparticles might be a possible AD risk factor. In addition to occupational settings (including, for example, exposure to printer toner powders, 3D metal printers), higher concentrations of magnetite pollution nanoparticles may arise in the indoor environment from open fires or poorly-sealed stoves used for cooking and/or heating, and in the outdoor environment from vehicle (tailpipe and brake wear) and/or industrial PM sources.

Presentation

## Carcinogenic organic compounds in PM1 particle fraction at an urban location with “canyon” effect

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### ABSTRACT

Street traffic has become one of the main air pollution sources in urbanized regions all over the world. Previous studies have shown that combustion of various fuels in metropolitan areas produces airborne particulate matter on which different compounds are absorbed. Carbonaceous aerosol is an important constituent of fine particles. Carbonaceous aerosol can be classified into organic carbon (OC) and elemental carbon (EC). OC is a complex mixture of hundreds of organic compounds that are produced directly or by atmospheric chemical processes. Within OC, polycyclic aromatic hydrocarbons (PAHs) are dominant carcinogenic components of atmospheric pollution.

The aim of this study was to determine the levels of eleven polycyclic aromatic hydrocarbons (PAHs) in $PM_1$ fraction of particle matter.

Measurements were carried out from January to December 2019 at a city street location surrounded by tall buildings. This location has a “canyon” effect where pollutants strongly accumulate in a small area due to weak ventilation. 24-hour samples of the $PM_1$ particle fraction were collected on quartz filters from about 55 $m^3$ air using a low-volume sampler. The analysis was performed using a high-performance liquid chromatograph (HPLC) with a fluorescence detector.

The average mass concentration of total PAHs was 2.554 ng $m^{-3}$, 0.812 ng $m^{-3}$, 8.167 ng $m^{-3}$ and 20.381 ng $m^{-3}$ for spring, summer, autumn and winter, respectively. The total concentrations of the eleven PAHs ranged from 0.069 ng $m^{-3}$ to 66.296 ng $m^{-3}$, with an average annual value of 8.198 ng $m^{-3}$. Based on the obtained mass concentrations of PAHs their contribution to the OC and $PM_1$ was analyzed and discussed.





Presentation

## Levels of carbohydrates in PM1 particulate matter emitted during wintertime

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### ABSTRACT

Most epidemiological studies regarding air quality and human health effects are performed on fine and coarse particles, as they are regulated by air quality directives. In recent years, ultrafine particles have been recognized as crucial because of their ability to reach the most distal lung regions and greatly impact the cardiovascular system. To get a better understanding of the health effects, it is important to determine the ultrafine particle composition in as much detail as possible since every compound has different chemical and physical properties.

This study focused on carbohydrates that represent water-soluble organic compounds. The presence of carbohydrates in the particulate matter can be caused by various sources, of which the most common is biomass combustion. Anhydrosugars, specifically levoglucosan, mannosan, and galactosan, which are formed by thermal cellulose and hemicellulose breakdown, are considered specific and general tracers for biomass burning emissions. Other carbohydrate sources are plants, spores, and bacteria, whose activity forms sugar alcohols and primary sugars.

The present study aims to investigate levels of carbohydrates in PM1 samples collected during wintertime at an urban background station. Twelve carbohydrates were examined and the results were compared with concentrations obtained from PM10 particulate matter analysis. Results showed that anhydrosugars are the most abundant, followed by sugar alcohols and sugars, respectively. Levoglucosan was the most dominant compound in both fractions and it was found that more than 90% of levoglucosan in the PM10 fraction is bound to the PM1 fraction. Because of the mutual pollution source, the results were compared with concentrations of polycyclic aromatic hydrocarbons in the PM1 and PM10 fractions. Spearman correlation showed a very strong correlation ($r > 0.82$) in PM1 fraction between levoglucosan, mannosan, galactosan, ΣPAH, benzo[a]pyrene, arabitol, and erythritol which implies a common origin of these compounds. Factor analysis revealed two main pollution sources in both of the fractions.

Presentation

## Tuning sampling and analysis strategies for UFP: Laboratory and field tests with selected PAH-marker components

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### ABSTRACT

Polycyclic aromatic hydrocarbons (PAHs) and their derivates bound to the ultrafine fraction of airborne particulate matter (PM) are suspected to expose a potential risk for human and environmental health. Additionally, ultrafine particles (UFPs) exhibit a large surface area where PAHs can influence their atmospheric transport, lifetime and ageing. For risk assessment we need to learn about the origin, behavior, mobility, fate, and toxicity of UFPs containing PAHs. But attempts to analyze their chemical composition in the atmosphere are still rare. Considering the low mass, partial volatility and dynamic character of UFPs, it is a great challenge to separate, collect and analyze them in the atmosphere.

Impactors are useful tools to separate and collect environmental particles from the air with the aim of analyzing their chemical composition. After careful physical characterization of different types of cascade impactors regarding their cut-off characteristic, pressure drop and sampling volume, we report on size-fractionated UFP sampling during the winter season in urban and rural areas in Bavaria, Germany. Different commonly applied impactors were operated simultaneously for different time-periods, partly after their optimization for the separation and collection of the ultrafine fraction. The chemical composition of the collected UFPs was examined off-line with chromatographic analytical methods. For testing our methods, we focused on the following specific marker components of PAHs: Phenanthrene, 2-Hydroxyphenanthrene, Pyrene, 1-Hydroxypyrene, Benzo(a) pyrene and 9,10-Phenanthrenequinone. Due to the low mass of UFPs and the variety of polarity of the chosen marker components, we developed suitable extraction methods adapted to the different analytical requirements. Our aims are, first to draw comparisons between the performance of the impactors, second to investigate different analytical methods for chemical UFP analysis and finally to provide data on the spatial distribution of UFPs containing PAHs. This project is financed by the Bavarian Ministry of the Environment and Consumer Protection.





Presentation

## Spatial and temporal variation of ultrafine particles in the Bavarian centres of the NAKO health study: Augsburg and Regensburg

Josef Cyrys[1], Kathrin Wolf[1], Marco Dallavalle[1,2], Susanne Breitner[1,2], Alexandra Schneider[1], Regina Pickford[1], Simonas Kecorius[1], Susanne Sues[1,3], Jens Soentgen[3], Annette Peters[1,2]

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### SHORT DESCRIPTION

Epidemiological studies on ultrafine particles (UFP) are challenging due to their short lifetime in the atmosphere and their large spatial and temporal variability. To date, reliable data on chronic exposure to UFP is therefore scarce, which in turn means that air quality standards for UFP have not been developed yet.

The overall aim of the project "Ultrafine particles in Bavaria - UFP concentrations and health effects in the Bavarian centres of the NAKO health study" is to assess the long-term health effects of UFP at the Bavarian centres of the NAKO health study, Augsburg and Regensburg. In order to estimate the chronic exposure of the study participants, land use regression models will be developed for both cities. For Augsburg, the project makes use of existing UFP measurements obtained in two previous measurement campaigns in the Augsburg area in 2014/15 and 2017 and a LUR model developed for 2014/15 within the framework of the ULTRA3 project (Environmental Nanoparticles and Health: Exposure, Modelling and Epidemiology of Nanoparticles and their Composition within KORA).

This LUR model will be updated and transferred to Regensburg then. In order to validate the Regensburg LUR model we conducted UFP measurements at six sites in the Regensburg area between June 2021 and March 2022.

These unique and extensive data sets collected during the three measurement campaigns (two in Augsburg and one in Regensburg) allow us to assess the spatial and temporal variability of the UFP concentrations within Augsburg and Regensburg and compare them with each other. We analyze the contribution of local emitters regarding their diurnal, weekly and seasonal variability and the influence of meteorological conditions on the formation and dispersion of UFP in each city. Initial results show a pronounced spatial variability and a rather strong temporal correlation of UFP levels in each city.

**Acknowledgement**
This project makes use of data obtained in the ULTRA3 study (Environmental Nanoparticles and Health: Exposure, Modelling and Epidemiology of Nanoparticles and their Composition within KORA) and the project "Influence of local sources on the spatial and temporal distribution of ultrafine particles". ULTRA 3 was supported by intramural funding for Environmental Health projects of Helmholtz Zentrum München—German Research Center for Environmental Health. The project "Influence of local sources on the spatial and temporal distribution of ultrafine particles" was supported by the Bavarian Environment

Presentation

## Characterisation of inhalable aerosols from carbon fibres

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Keywords: carbon fibres, WHO fibres, aerodynamic diameter,

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### ABSTRACT

Carbon fibres (CF) and CF-reinforced plastics (CFRPs) are innovative materials, which are increasingly produced, recycled and disposed, possibly releasing particles and fibres. The BMBF project "Carbon Fibre Cycle – CFC" has the aim to identify respirable particles, fibres and fibre fragments after thermal and mechanical treatment of CF/CFRP, to analyse them and to assess pulmonary toxicity. The physical properties of CF being similar to asbestos raise serious concerns about potentially harmful effects in the lung.

Inhalable aerosols of mechanically or mechanical-thermally treated CF are provided and characterized, which are deposited at the air-liquid interface onto human lung cells in an exposure system, where toxicological investigations are carried out, i.e. directly on the apical surface of cell cultures, in order to simulate lung-like conditions. Lung epithelial cells and macrophages in mono and co-culture are used for toxicological evaluation of respirable CF fragments focussing on determination of cytotoxicity, gene expression analyses and determination of proinflammatory, profibrotic and genotoxic potential.

Commercial short carbon fibres based on polyacrylnitrile (PAN) were investigated after mechanically or mechanical-thermal treatment. The aerosol from the exposure system was on the one hand sampled on filters which were analysed by different microscopy methods and on the other hand the deposited dose on the cell surfaces was measured. All images from digital and scanning electron microscopy were evaluated using the image analysis software FibreShape (IST AG, Switzerland) in combination with own data post processing. The fibres were analysed regarding length, diameter and in a further step the aerodynamic equivalent diameter was calculated. Fibre characterisation is discussed in the context with biological responses caused by inhalable CF.

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Presentation

## RELATIONSHIPS BETWEEN OXIDATIVE POTENTIAL OF PM SIZE, COMPOSITION & SOURCE APPORTIONMENT IN URBAN & REGIONAL BACKGRPOUND IN BARCELONA, NE SPAIN

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### ABSTRACT

We analysed the oxidative potential (OP) of $PM_{10}$, $PM_{2.5}$, and $PM_1$ sampled along one year (2017-2018) at two (a regional background and a urban background) supersites in Barcelona, NE Spain, to evaluate the relationship between OP and the PM size, the levels of a number of PM components and the source contributions to PM. To this end we compiled an extensive dataset of inorganic chemical speciation obtained from the analysis of the content of around 40 PM components in each of filter sample, and used receptor modelling tools (Positive Matrix Factorization, PMF) for source apportionment. Finally, OP was analysed using a fraction of each filter sample by measuring the the reactive oxidative species (ROS) using a dithiothreitol (DTT) and ascorbic acid (AA) assays. Using these data, a multilinear regression model (MLR) was created to determine the intrinsic toxicity of chemicals and source in different PM sizes.

The results evidenced that in the case of Barcelona, the intrinsic toxicity of the sources had an inverse ranking compared to the mass contribution of each source, with industry PM source contributions being the source with the highest intrinsic toxicity. This study showed that anthropogenic sources as combustion, road dust, and industry are the most toxic sources when looking at human exposure, but SOA is also a significant contributor in $PM_{10}$ in BCN and in all PM sizes in MSY. Very interesting differences were obtained in the prevalent source contributions to OP for different PM sizes. As an example, $PM_{2.5}$ OP of road dust is higher than in PM10, while in PM1 industrial PM has a higher OP than road dust. Data is presented as the OP apportionment for each PM size and site per $m^3$, but also as OP per µg of PM for the different source contributions to evaluate the intrinsic OP of PM components and source contributions.

Presentation

## Validation of an Aerosol Exposure Air-Liquid-Interface (AE-ALI) system to facilitate more realistic hazard identification of nano-sized aerosol exposure in human relevant culture models

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### ABSTRACT

Air pollution is one of the greatest environmental risks to public health. To facilitate more realistic hazard identification, especially for inhalable particulate matter and engineered nanomaterials, we have established an aerosol exposure air-liquid-interface (AE-ALI) system (CultexTM). Whilst offering potential benefits in terms of more realistic hazard identification, this AE-ALI system can be complex to operate and the results sensitive to details of set-up and operating parameters. As such, detailed characterization of the system, including assessing the effects of electrostatic precipitator voltage, aerosol flow rate, size of Transwell inserts, and exposure duration on cytotoxicity (LDH), was carried out using human lung alveolar (A549) and primary small airway epithelial cells to ensure robust and repeatable results. The primary small airway epithelial cells were used to explore for any further adverse effects such as oxidative stress, inflammatory responses, and DNA damage. The results indicated that exposure duration had a significant impact on cell cultures (e.g. increased expression of selected genes including CXCL1, HMOX1, SPP1 etc). The effect of system parameters on nanoparticle (NP) aerosol deposition patterns was also explored using a CeO2NP aerosol and laser ablation ICP-MS. The results show that appropriate choice of operating parameters could produce broadly uniform deposition. Results from this study indicate that detailed characterisation of AE-ALI systems is essential prior to use.





Presentation

## Abstract submission for the topic: Health effects and mechanisms

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### ABSTRACT

**Functional Effects of Carbon Black Nanoparticles on Primary Airway Epithelial Cells in vitro**

Health effects of carbon black and other nanoparticles in humans are not properly understood for risk analyses. Particles mainly enter our bodies via the respiratory tract, but effects on human airway epithelia or the extent of particle exposure are unclear.

To address this knowledge-gap, epithelial in vitro-models are generated from human nasal mucosa biopsy material [1]. Autologous fibroblasts are cultured basolaterally on transwell membranes, and epithelial cells are expanded and cultured apically. Co-cultures are transferred into air-liquid interface (ALI) conditions and further cultivated for approximately 4 weeks. Models are evaluated by light microscopy. The ALI-models are exposed to carbon black ultrafine particles (UFP). Particles are distributed onto cell cultures by nebulizing cell culture medium containing UFPs at different concentrations. (Geno-)toxicological assessments are performed using the comet assay and the MTT test. The transepithelial electrical resistance (TEER) is assessed as a proxy for barrier function.

After approximately 30 days, our co-cultures display a multilayered, stratified epithelial model with beating cilia and mucus production. A sufficient barrier is present, as measured by TEER (>400Ω). Our data suggest that carbon black exposure can disturb the barrier integrity from 4µg/cm2 but with significant donor variation. No concomitant DNA damage or changes in cell viability was detected, which are traditional indicators of toxicity.

Thus, carbon black may induce barrier debilitation at non-toxic concentrations. Assuming a particle deposition of only 1%, as has been suggested to be more realistic [2], corresponds to the significantly lower concentration of 0.4µg/cm2. Hence, this low concentration could induce barrier failure in some individuals. Further functional testing appears to be relevant for risk assessments. Comparing with city air concentrations of UFP around 5µg/m3 [3], we lie two orders of magnitude higher with 1% of 4µg/m2 (400µg/m3), however such direct comparisons do not reflect the complex reality.

**References**

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Presentation

## Short term and long term exposure to UFP of Schiphol Amsterdam airport

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### SHORT DESCRIPTION

Ultrafine particles associated with airport activities have been shown to disperse up to at least 20-30 kilometres from the Amsterdam airport. As particles from the turbine engines of aircraft tend to be smaller (10-20 nm) than those from road traffic (30-70 nm), this difference has been used for source apportionment and health effects studies (toxicological, volunteers, panel and cohort).

Key findings will be presented.