

Extended Summary:

UFIREG - A European-wide approach to define health impacts of ultrafine particles in urban ambient air

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Information on health impacts of ultrafine particles is still limited. So far only few epidemiological studies link health effects, in particular cardiovascular dysfunction, directly with environmental ultrafine particles.

The aim of the UFIREG-project is to investigate short-term effects of environmental particles in seven different size classes in the range from 10 to 800 nm. Emphasis is given on mortality and morbidity, especially on cardiovascular diseases. The project started in July 2011 and is funded by the European Regional Development Fund Financing Programme Central Europe. The project team consists of experts on air pollution control and public health from Germany, Czech Republic, Slovenia and Ukraine.

Within the project, ambient number size distributions of (ultra)fine particles are determined in five European cities with different background: Dresden, Augsburg, Prague, Ljubljana and Chernivtsi. Most of the measurement stations are integrated in local air quality monitoring networks and are located at urban background sites to be representative for the majority of inhabitants. Additionally, other air pollution parameters such as PM₁₀, PM_{2,5}, NO₂ and SO₂ as well as meteorological parameters are measured at these stations to allow correlation analyses between these parameters and the existence or formation of (ultra)fine particles. Furthermore, a meteorological cluster analysis based on back trajectories will be performed to classify the UFP pollution as function of air mass origin. Applying source apportionment methods to the particle number size distribution data different particle emission sources will be identified and the source activities in the different cities can be compared.

Measurements of urban atmospheric aerosol particles in the scope of UFIREG are performed using Mobility Particle Size Spectrometer (SMPS and TDMPMS). The project adopted the sampling standard of other regional monitoring networks such as GUAN (German Ultrafine Aerosol Network) and ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure Network) and agreed to measure at a relative humidity below 40 % to obtain comparable measurements. The consequence is that the sample air has to be dried with Nafion membranes. In accordance with the EU directive 50/2008 the maximum sampling height is four meter at all stations.

Moreover, an extensive quality assurance program is an essential part of the UFIREG-project and is based on several sequent steps to guarantee a high data quality and to obtain

comparable data between the measurement stations. In a first step, an aerosol training course for the less experienced project partners was held in January 2012. In a second step, an initial comparison workshop for all UFIREG SMPS took place at the World Calibration Center for Aerosol Physics (WCCAP) in March 2012. Each of the four commercial and non-commercial SMPS was compared against a reference SMPS of the WCCAP. All instruments deviate not more than $\pm 10\%$ for non-diffusive particles against the reference SMPS for the size range from 20 – 200 nm (Figure 1). The second goal of the comparison workshop was to educate technicians of the respective measurement stations to operate the SMPS. In a last step, on-site instrument comparisons will be frequently done against the WCCAP reference SMPS over a period of two years. Additionally, automatic control units are installed at two of the UFIREG-SMPS (Dresden and Chernivtsi). With the help of these control units leak tests can be done automatically and total number concentrations can be compared easily and exactly with a parallel measuring Condensation Particle Counter.

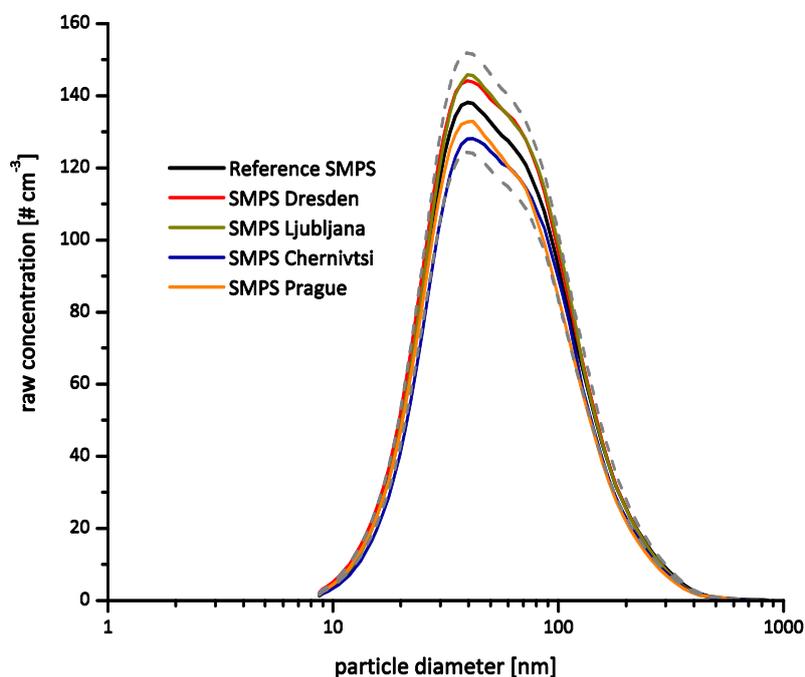


Figure 1: Intercomparison workshop at the WCCAP in Leipzig

In addition to the high size resolution measurements with a SMPS, UFP monitors (TSI 3031) are employed at three UFIREG-sites (Prague, Dresden and Augsburg). Herewith, the long term stability of the UFP monitor for ambient air measurements can be determined. With this information the project partners will give a recommendation if this UFP monitor can be used for air quality monitoring networks in future.

On the basis of the measured air quality data, epidemiological studies will be carried out in all participating cities. The results will help to provide recommendations to minimize environmental and health risks associated with ultrafine particles. Therefore, important results will be passed on to health insurance providers, policy makers, environmental and health authorities as well as citizens to influence environmental and health policy.

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UFIREG – Project motivation:

Limited information on health impacts of ambient ultrafine particles, positive associations of (ultra)fine particles and cardiovascular mortality and blood inflammation markers shown by few studies

UFIREG – Aim:

Investigation of short-term effects of seven different size classes of environmental particles in the range from 10 to 800 nm on mortality and morbidity, especially on cardiovascular and respiratory diseases

UFIREG – Team:

Experts on air pollution control and public health from Germany, Czech Republic, Slovenia and Ukraine

UFIREG – Measurement sites:

- In five European cities: Dresden, Augsburg, Prague, Ljubljana and Chernivtsi (Fig. 1)
- Integrated in local air quality monitoring networks
- Located in the urban background

UFIREG – Measurements:

- Particle number size distributions
- Additional air pollution (e.g. NO₂, SO₂, O₃, PM₁₀, PM_{2,5}) and meteorological parameters



<http://www.ufireg-central.eu>



Fig. 1: UFIREG - Measurement sites

UFIREG – Instrumentation:

Mobility Particle Size Spectrometer (SMPS, TDMPS) and UFP-Monitor (TSI 3031/UFP 330)

UFIREG – Sampling standards:

Adopted from other regional monitoring networks such as GUAN and ACTRIS and in accordance with the EU directive 50/2008, e. g.

- Sampling height between 1,5 and 4 m
- PM_{2,5}/PM₁-separation
- Drying of the aerosol with Nafion membranes to reach a relative humidity below 40 %
- Laminar flow sampling with tubes as short as possible

UFIREG – Quality assurance program:

Essential part of the project to guarantee highly quality-assured and comparable data between the measurement stations

- Aerosol training course for the less experienced project partners (January 2012)
- Initial comparison workshop for all SMPS at the World Calibration Center for Aerosol Physics (Fig. 2) including education of the technicians in operating the SMPS
- Installation of automatic control units
- Frequent on-site instrument comparisons against a WCCAP reference SMPS and CPC

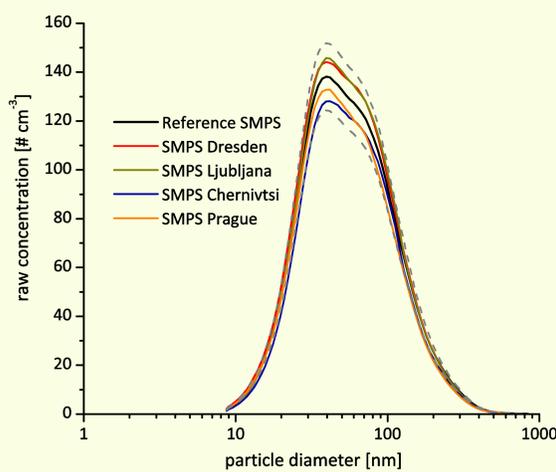


Fig. 2: UFIREG – Intercomparison: In the size range from 20 to 200 nm, all instruments deviate not more than +/- 10 % against the WCCAP reference SMPS.

UFIREG – Station Dresden:

- Additional soot (black carbon) measurements with a Multi Angle Absorption Photometer (MAAP)
- Automatic control unit with two options (Fig. 5):

1. Comparison of number concentrations of SMPS and CPC without nucleation mode particles due to losses in a set of 30 diffusion screens
2. Zero/leak test

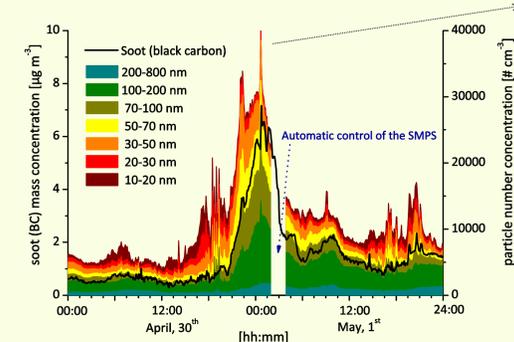


Fig. 3: High particle number and soot (black carbon) mass concentrations in Dresden during the May Fire night 2012

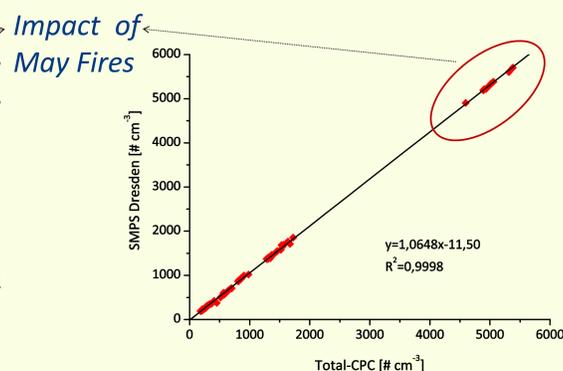


Fig. 4: Comparison of particle number concentrations of SMPS and CPC after passing 30 diffusion screens (April 18th - May 3rd)

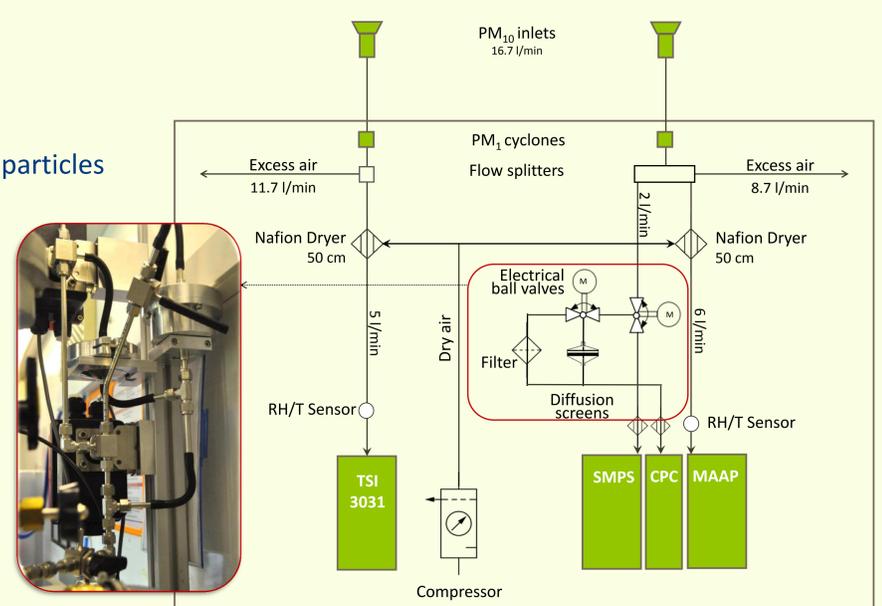


Fig. 5: Installation sketch of the aerosol measurement instruments in the station in Dresden; the automatic control unit is marked in red and shown in the photograph

On the basis of the measured air quality data, epidemiological studies will be carried out. The results will help to provide recommendations to minimize environmental and health risks associated with ultrafine particles.