AirMonTech
Air Pollution Monitoring Technologies for Urban Areas

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AirMonTech Newsletter

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Welcome to the 2nd AirMonTech newsletter!

Time flies, and we are already entering the final year of AirMonTech. The first phase of the project was marked with an energetic enthusiasm motivated by the challenges ahead of us. Lots of credit goes to the excellent team of scientists who have worked hard to evaluate current and future technologies in the monitoring of air quality. Another product, the design of the AirMonTech database, will provide a flexible portal to all the information for all stakeholders. We strongly believe that these are the right ingredients to open up the road to a new and refocused monitoring strategy in Europe.
The Consortium was very pleased to present the progress in the project at the 2nd AirMonTech workshop in Barcelona on the 25th and 26th of April. The interest in the project was reflected by the number of participants which was above expectations (more than 100!). In this Newsletter we will give you an update on the outcome of this workshop and I hope it will also encourage you to participate in the widening AirMonTech network. If you wish to join us at our future meetings, please contact us via the website www.airmontech.eu and we will keep you informed.

Thomas Kuhlbusch (project coordinator)

Announcement next AirMonTech events

Although we have the Barcelona workshop still in our minds, we are already looking forward and invite you to two important AirMonTEch-events in 2013:

⇨ The **3rd AirMonTech Workshop** will take place in **Duisburg, Germany (March 2013)**. The focus of this workshop will be the final database as well as the discussion and finalization of recommendations for future urban air quality monitoring. This event will be organized in cooperation with EuNetAir, a COST Action on new sensing technologies for air-pollution control and environmental sustainability.

⇨ **Final Conference in Brussels (May 2013)**

Detailed information on the programmes of both events will be made known on the AirMonTech website.

Focus on the 2nd AMT workshop Barcelona, April 2012

How to monitor air quality in Europe in future? Which measurement technologies will be available? Should the monitoring in networks be extended to other pollutants or health-related characteristics that yield data valuable for health effect assessments? And, if so, which instruments are best? Where do we find all relevant information?

These (and other questions) were the focus of the 2nd International Workshop 'Current and Future Air Quality Monitoring' which took place on 25th and 26th April 2012 in Barcelona, Spain. The first AirMonTech workshop was successfully held in December 2010 in London (UK).

The Barcelona workshop attracted more than 100 participants from all over Europe, forming a mixed audience of health experts, scientists, instrument manufacturers and developers, as well as representatives from national and EU administrations.

The presentations of the individual speakers are available for download at http://www.airmontech.eu/publications. Summaries of the different presentations are given below.

Health Effects

During the Barcelona workshop, options for the integration of air quality monitoring with health effect studies were extensively discussed. It was shown that results of epidemiological research largely depend on the quality and type of measurement data that are provided by monitoring networks. As a consequence, the relation between health effects with regulated pollutants is better studied than with other non-regulated pollutants, although those may be as important. As there is still a substantial lack of knowledge, the design of monitoring networks in future should take into account the needs of health research, while not neglecting the task of ensuring compliance with air quality standards.

Exposure Assessment

The presentations in the Barcelona workshop and the corresponding discussions gave an inspiring basis for the recommendations that will be set out in AirMonTech at the end of 2012. It is evident that health experts need more data on personal air pollution exposure to unravel the origin of air-pollution related health effects. In the first place, this implies data with a higher temporal and spatial resolution. As this cannot be reached with the "traditional" monitoring networks, the implementation of different categories of sites should be taken into consideration, e.g. by creating "supersites" with appropriate geographic coverage that include the measurement of health-related parameters (like ultrafine particles, elemental carbon, reactive oxygen species formation potential) in a harmonized manner. These sites could be complemented by mobile measurement units and sensor technologies to give the necessary distributions, and by data from remote sensing and dispersion modelling.

Essential for the determination of exposure of city inhabitants is also the knowledge of people's time-activity-location patterns in combination with synchronized concentration data of the various microenvironments where people reside. In this respect, the technique of personal monitoring by sensor was demonstrated at the workshop to be very promising for the (near) future. When the technique improves further it is expected to be very valuable in providing data for exposure modelling, perhaps when combined with smart-phone technology.

Summary of Presentations Day 1

Klea Katsouyanni (University of Athens) discussed the integration of air quality and health effects monitoring. She showed that results of epidemiological studies largely depend on the kind and quality of data made available by the established monitoring networks. To assess personal exposure to air pollution, data with high temporal and spatial resolution are needed. However, since not all monitoring systems and sites can provide such data, the creation of "supersites" or "special" sites is proposed. Mobile or lower-specification measurement units may be employed to complement these fixed-site measurements in specific situations. Monitoring networks should be designed with input from health researchers. Up to now, decision makers regulating the routine air pollution monitoring in Europe have not been very responsive to the needs of this research. They request sufficient scientific evidence before introducing new regulations. However, convincing evidence can only be produced when adequate measurement data become available! As a first step, more interaction between decision makers and exposure specialists on the one hand and health researchers on the other should be established (e.g. AirMonTech!).

Gerard Hoek (Utrecht University) presented on the use of ambient air quality monitoring for exposure assessment. He stated clearly that long daily series of pollutant concentrations are necessary to determine short-term health effects effectively . For many relevant pollutants including PM2.5 and PM10, concentrations measured at one site are well correlated with those at other sites in a city. Hence networks are very useful for short-term effect studies. For the long-term effects, however, series of annual averages are needed, preferably with a high spatial resolution. To assess long-term exposures for health assessment from networks, various challenges need to be overcome, including sufficient spatial density, often making interpola-

tion by models necessary. It was pointed out that monitoring network data can be successfully applied in land-use regression (LUR) models at a relatively low cost. Other challenges are site selection relevant for human exposure (kerbside is often not too relevant), the most relevant particle metrics (not necessarily those regulated and therefore measured) and consistency of methods across time and space.

He further indicated that exposure to vehicular emission occurs threefold: in the urban background (to which vehicular emissions always contribute), along roads (when living, working or going to school there) and while participating in traffic. The highest exposure takes place while commuting (by bus, car or bicycle) in the urban agglomeration, in particular, inside moving vehicles. Compared to the average levels at nearest monitoring stations concentrations can be three times higher! The conclusion was that measurements in monitoring networks are not really appropriate for exposure assessments concerning commuters.

Airmontech Database

SOPs and Type Approvals

Robert Gehrig (EMPA, Switzerland) described the progress made in AirMonTech with regard to the measurement techniques of regulated air pollutants. Information on performance and optimal use of available instruments for regulated air pollutants was compiled to improve and harmonize air quality measurements in Europe. For this purpose relevant documents (type approval test reports, standard operating procedures (SOP), equivalence test reports) were collected from instrument manufacturers and various national and local authorities.
Additionally, a set of documents was produced by the AirMonTech consortium to give a first information overview and some guidance:

- Metric Basic Information (MBI) including definitions and information on sources, health relevance, regulations and reference methods.
- Metric Measurement Technology Overviews (MMTO) listing measurement technologies, typical operational characteristics and hints about the applicability.
- Metric Measurement Technology Information (MMTI) containing details for each technology.
- Model Standard Operating Procedure (MSOP) supporting network operators in setting-up or updating an SOP and giving example text for the necessary points which need to be addressed in an SOP.

All these documents are made available in the AirMonTech database which will soon become public. The documents collected from network operators and manufacturers are uploaded as provided. If appropriate, major caveats will be expressed in the file description (meta-tags) which will appear together with the download-link on the database webpage.

The first call for documents for regulated pollutants led to the submission of about 100 SOP, specification and application sheets on various measurement techniques from 16 countries. These as well as reports on equivalence testing for PM monitors have been introduced into the database. The current status on the revision of the standard on Type Approval and Certification of Automated Measuring Systems in Europe was discussed and found to be important at the workshop. Obviously many manufacturers still hesitate to make these reports available. A second call for documents will be launched after going public with the database.

Maurizio Barbiere (JRC, Italy) presented the database developed within AirMonTech. Various documents are and will be stored in this database, e.g. type approvals, SOPs, Metric Background Information etc. He described its architecture (web interface – server – database information) and showed how to access it. There are different roles in the management and uploading of the Database: JRC is the “administrator”, the consortium members are authorized “editors” in charge of collecting and uploading the documents. The different tools to retrieve information from it were shown by a live demonstration of the database. The Database final version is expected to be available with free access in the summer of 2012 for the AQ community, stakeholders and other interested parties. For now, a demonstration version is available that can be tested and commented on. To do so, a password can be acquired by sending an e-mail to db-airmontech@jrc.ec.europa.eu.

Certification

Karsten Pletscher from TÜV Rheinland Energie und Umwelt GmbH (Germany) introduced the latest standard in type approval and certification of automated measuring systems (AMS). Type approval and certification are essential for quality assurance when monitoring emissions and ambient air. In close cooperation, Germany and the United Kingdom have implemented procedures for type-approval and certification of AMS for many years. Based on this experience, the standard series EN 15267 “Certification of automated measuring systems” was developed. The result is that, for the first time ever in Europe, a uniform and obligatory scheme to test and certify

Diffusion Classifier

AMS is available. Performance criteria and test procedures for ambient air monitoring are laid down in several European standards, each specific for one particular measured component

The EN 15267 certificate (QAL1 certificate) is issued by the relevant national body after the corresponding type approval test, carried out by a test laboratory accredited according EN ISO/IEC 17025 for type approval, is passed, and after successful audit of the manufacturing process. The certificate is published in an official register (in Germany: www.qal1.de; in the UK: www.mcerts.net) to allow the largest possible transparency.
Up to now only Germany and the United Kingdom have explicitly implemented the certification scheme according to EN 15267. In terms of European harmonization and with respect to the given target of "Mutual recognition of data" (Annex VI chapter E of the Directive 2008/50/EC), a close cooperation between the relevant bodies in Europe is therefore highly encouraged.

Sensors

Reactive Oxygen Species

Markus Kalberer (Univ. of Cambridge) presented new developments in the time-resolved, online determination of Reactive Oxygen Species (ROS) formation potential by ambient particles. The three formation routes of ROS in relation to aerosols were explained. The instrumentation developed allows online measurements of the ROS formation. Advantages of this approach include a minimization of losses of reactive components and a higher time resolution. Examples were presented on: a) chamber experiments of photochemical formation of Secondary Organic Aerosol (SOA) from motorbike emissions showing higher ROS of the SOA compared with Primary Organic Aerosol, and higher ROS of EURO1- compared with EURO2-compliant vehicles, and b) preliminary online ambient urban air data for ROS showing higher ROS compared to clean air.

Personal Exposure

Mark Nieuwenhuisen discussed his studies on personal monitoring, on how the data compares to air quality measurements, and what additional information can be derived. Results show that outdoor and personal concentrations are not well correlated, whereas correlation is higher for indoor and personal exposure. Examples of cohort, commuting and city scale time and spatial exposure assessment were presented.

Summary of Presentations Day 2

Martin Fierz of the University of Applied Sciences Northwestern (FHNW, Switzerland) gave a presentation on the use of diffusion charging for easy monitoring of an "integral particle" metric. The simplest instrument is the "diffusion charging sensor" (DCS), which collects all charged particles on a filter and then measures the current deposited on the filter. Interestingly, this current correlates very well with the lung-deposited particle surface area (LDSA) for alveolar and bronchial tracts of the lung. The LDSA is a dose, and therefore one step closer to health effects than exposure values which are typically measured today (ambient concentrations of, e.g, PM10 or particle number concentration). This very simple instrument therefore happens to measure a quantity that is likely to be health-relevant, as numerous toxicological studies have shown that particle surface area correlates better with some health endpoints than either particle mass or particle number. At the same time, the simplicity of the principle of operation allows a low-cost, reliable and miniature implementation of the principle. Implementation of this principle in three commercial instruments and their pros and cons were presented.

Michel Gerboles (JRC, Italy) showed today's capabilities of sensors and sensor-based technology. A number of modern examples of systems using sensors combined with wireless data transfer and GPS were introduced (e.g. Unitec outdoor air quality monitor, Aeroqual, Berkeley badge). Developments continue to face technical problems like zero drift and temperature/humidity effects on the sensor's response. Commercial sensors for CO, NO2 and O3 exist in the appropriate ranges but validation studies remain scarce. Therefore the EU project MACPoll 'Metrology for Chemical Pollutants in Air' was introduced which focuses on the suitability of sensor as indicative devices and the validation of a number of commercial sensors for O3 and NO2. From a number of recent pilot projects (such as the JRC ship plume monitoring with an unmanned aerial vehicle, or the US "CommonSense" project) it is concluded that the improvement of sensitivity, stability, and selectivity, and the reduction of power consumption are the main tasks in future. Some further lessons learned were summarized: the sensor technology is still in an early developing stage. It can only be used as an indicative instrument and not for regulatory purposes. Applications combining sensors with Web based systems and GPS are now available, but validated sensors for monitoring at ambient air levels are still missing. A better demonstration is needed of the validity of spatial distributions obtained by using sensors, even for informative applications.

COST EuNetAir

Michele Penza (ENEA, Italy) gave an overview on the new COST Action entitled European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability (EuNetAir) (2012-2016; http://www.cost.eu/domains_actions/essem/Actions/TD1105). The main objective of this concerted action is to develop new sensing technologies for Air Quality Control by setting up an interdisciplinary top-level network within the European Research Area (ERA). It is led by ENEA (Italy), and 60 institutions from 21 COST Countries (EU-zone) and 5 Non-COST Countries (extra-Europe) also participate. The Action will define innovative approaches in sensor nanomaterials, gas sensors, and wireless sensor-systems. The network will form a critical mass of researchers to give training and education, to coordinate outstanding R&D, to promote innovation towards industry, and to support policy-makers and regional decision-makers.

Black Carbon

Xavier Querol (CSIC, Spain) identified the advantages of using optical online detection techniques for the determination of Black Carbon (BC) for exposure assessment and evaluation of mitigation options. Care has to be taken with the development of congruent approaches within EMEP and urban air quality monitoring, as requirements may be significantly different. He concluded that PM10 (a mixture of source contributions) and BC (tracer for traffic and biomass burning) is a good combination for air quality monitoring, especially because exceedances often occur at traffic hotspots.

Future Monitoring

André Prevôt (PSI,Switzerland) showed the potential of the Aerosol Chemical Speciation Monitor (ACSM) for long-term monitoring. The ACSM is a smaller version of the Aerosol Mass Spectrometer, designed for a low-maintenance, robust operation but with reduced sensitivity, mass resolution and no particle size information. This instrument allows high-time resolution measurements of the chemical composition of organics and secondary inorganics (nitrate, sulphate, ammonium and chloride). It was concluded that the ACSM is an instrument that can be used in routine monitoring by researchers but also by the authorities. Advantages are the higher reliability, lower costs and easier handling of the ACMS compared to the AMS. It allows the quantification of sources of organic aerosols (like traffic, wood burning, cooking, secondary organics) over long-term periods. To provide simultaneous measurements of BC, other instruments are necessary (e.g. aethalometers).

Instrumentation Trends

Thomas Kuhlbusch (IUTA) presented results of an analysis of new measurement devices for established and alternative air quality characteristics. The data were collected within the framework of collecting information for the AirMonTech database on new measurement techniques and additional air quality indicators. Following major trends were identified:

- Improved performance of measurement devices by new techniques and higher time-resolution,
- Miniaturisation: compact monitoring „stations“ and developments of handheld detectors and microchip sensors,
- Multi-component detection: for particles (elements, organic matter, soluble matter) and gases in one sampling and analysing instrument,
- Open-path monitoring: allowing mapping of the air quality over a city, also enabling model validation,
- New chemical-physical metrics and possibly health relevant proxies: these include the determination of the potential of particles to form reactive oxygen species (ROS), of lung deposited particle surface areas and black carbon,
- On-line in-vitro assays to directly assess the hazard potential of ambient air constitutents.

These trends and new possibilities in assessing ambient air quality and population related exposure also open up a multitude of options to improve, widen, re-direct and re-consider air pollution monitoring strategies with the goal of the effective reduction of possible health effects by ambient air pollutants.

Paul Quincey (NPL, UK) introduced the progress made with regard to ‘Options and Strategies: Urban Air Quality Monitoring Technologies in Context’. The tasks of AirMonTech Workpackages 1, 2 and 3 include making an up-to-date assessment of the available technologies for monitoring both currently regulated pollutants and non-regulated pollutant metrics. His talk set out to describe:

- Various monitoring strategies, suited to regulatory or other purposes, within which the monitoring would be carried out;
- Other monitoring data that are available, notably from the EMEP networks;
- Relationships between pollutants and other metrics such that monitoring one specific pollutant or metric could provide information of more general significance, as a proxy.

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Horizon 2020

Human health effects are clearly another major factor; these were covered in other talks at the Workshop. The main conclusions were that:

- The objectives of the current and future regulatory networks need to be explicit, setting out the balance between regulatory and scientific purposes.
- The focus of networks required by the Air Quality Directive should be broad enough at least to include the assessment of compliance with EU standards in background and hotspot sites, and the assessment of population-based exposure.
- There should be explicit supplementary aims of addressing scientific questions about sources and pollution control measures.
- There should be explicit coordination of objectives with regional-scale networks, notably EMEP.
- There should be explicit harmonisation of measurement methods and QA/QC procedures with EMEP and other relevant networks.
- There needs to be some flexibility in requirements to encourage the uptake of new technologies, to respond to changing priorities, and to reduce "monitoring inertia".
- Consideration should be given to moving away from a strategy of comprehensive monitoring networks for each pollutant, to one of having a combination of permanent "supersites" measuring a large range of pollutants in carefully-chosen sites, supplemented by other monitoring techniques and modelling.

Michel Schouppe (EC) presented the current state of European air quality and how it is currently perceived, the role of AirMonTech, and future perspectives. A key statement was that despite reductions, particulate matter, ozone, nitrogen dioxide and some organic compounds still pose a threat to human health and that too many ecosystems are still affected by an excess deposition of atmospheric nitrogen. It is noted that pollutant concentrations frequently exceed limit values. Many member states will not comply in time with the legally-binding air quality limits. More international cooperation will be needed to meet these goals.

The expectations of the European Commission regarding AirMonTech were enumerated. Its main deliverables (the database with detailed information of recent and new technologies, and a set of recommendations on harmonisation, adoption of new monitoring devices, and possible new health relevant metrics) should favour the harmonization of air pollution monitoring and the implementation of environmental policies and strategies in Europe. A large number (>20) of EU projects are concerned with ambient air pollution, associated health effects as well as climate change. These will all provide science-based evidence for the review process after 2012. Consultations have already resulted in a number of key issues being raised, such as a demand for simplification and focus ('limit values redundancy') in the case of PM, health justification (NO_2), the choice of ozone metrics, the introduction of new standards and possibly the deletion of some older standards. The presentation ended with an overview of Horizon 2020, its societal challenges, and, in reference to air quality, its specific challenges: fostering smart cities (Energy), efficient transport and mobility (Transport), and sustainable management of resources (Climate Change).

The AirMonTech team in Barcelona; lower level (from left to right): T. Kuhlbusch (Coordinator;IUTA), B. Schlierkamp (UDE), C. Hüglin (EMPA); top level: R. Gehrig (EMPA), E.Weijers (ECN), A. Borowiak (JRC), P. Quincey (NPL), L. Spano (JRC), M. Barbiere (JRC) and M. Viana (CSIC). Not on the photo: K. Katsouyanni (NKUA), X. Querol (CSIC), K. Torseth (NILU), R.Otjes (ECN) and U. Quass (IUTA).

PARTNERS