AirMonTech

Air Pollution Monitoring Technologies for Urban Areas

May 2013

AirMonTech Research Roadmap

AirMonTech is a European research project co-financed by the European Commission in the 7th Framework Programme

SEVENTH FRAMEWORK PROGRAMME

Recommendations on Automated Instrumentation for Future Urban Air Quality Monitoring

Introduction

The AirMonTech project's primary roles are to assess the current and near-future state of air quality **instrumentation** and monitoring practice, presented in the AirMonTech database[1], and to make recommendations regarding instrumentation, monitoring practice, and necessary research in the context of future regulatory monitoring, to help with the revision of the Ambient Air Quality Directive 2008/50/EC and beyond. The emphasis is on automatic instruments for urban monitoring.

Instrumentation cannot be seen in isolation. Before forming conclusions on instrumentation, the relevant metrics need to be identified. It would be short-sighted to assume that only the **metrics** that currently feature in legislation will be appropriate in future, especially for particulate matter, whereas conclusions covering all possible metrics would be unnecessarily long and complicated.

The choice of relevant metrics, in turn, depends on the **purpose** of the monitoring. It is clear, as explained below, that to focus exclusively on assessing compliance with legislation misses opportunities to, at least, improve the effectiveness of the legislation in the future. Providing information to clarify health effects is the most obvious example. Valuable extra knowledge can be gained from regulatory monitoring without a significant increase in costs.

So while the focus of the project is on instrumentation, there has also been significant expertise applied to, for example, **health effects,** and monitoring for purposes other than compliance with the Directive. In this regard, the work of AirMonTech is parallel to several other major exercises, such as the World Health Organisation REVIHAAP project looking at air pollutant health effects, and the Science Air Quality Research Review (coordinated through the ACCENTplus network)[2], looking at scientific issues. On instrumentation and monitoring practice, there is overlap with the AQUILA review of these areas. The REVIHAAP project, which has three AirMonTech partners on its Scientific Advisory Committee and Review Board, reported preliminary findings in January 2013[3]. It has been possible to consider these results while preparing these conclusions. The other reviews have not yet been published.

Air quality modelling was identified as another key area, complementary to monitoring. Modelling experts participated extensively in workshop discussions. Harmonisation and research relating to urban models is clearly needed, and this takes place in Europe primarily through the FAIRMODE forum. Some modelling recommendations are included here.

Data integration was also identified by AirMonTech as a key area. It is also a major focus of the COST action EuNetAir, which began in 2012. AirMonTech and EuNetAir collaborated extensively, holding a joint workshop in March 2013. Integration of monitoring and modelling features strongly in the research roadmap.

These AirMonTech conclusions take the form of a concise set of recommendations which have been summarized below. Supporting information is given in the body of the final report to be downloaded from the AirMonTech website. A research roadmap for Horizon 2020, to achieve the envisaged improvements within this period, is also presented.

The context of the monitoring

1. The objectives of the current and future monitoring networks need to be explicit, setting out the balance between regulatory and scientific purposes.
2. 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 appropriate for health effect studies.

[1] *http://db-airmontech.jrc.ec.europa.eu/*
[2] *http://www.ec.europa.eu/environment/air/review_air_policy.htm*
[3] *http://www.euro.who.int__data/assets/pdf_file/0020/182432/e96762-final.pdf*

3. There should be explicit supplementary aims of addressing scientific questions about sources, pollution control measures and monitoring for specific studies on health effects, defined in collaboration with the corresponding scientific communities.
4. There should be explicit cooperation with regional-scale networks, notably EMEP, covering common objectives. There should be explicit harmonisation of measurement methods and QA/QC procedures with EMEP and other relevant networks, as far as the purposes of the measurement allow.
5. 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”.
6. 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 “research sites” measuring a large range of pollutants in carefully-chosen sites, supplemented by other monitoring techniques and modelling.
7. Given the high spatial inhomogeneity of urban pollutants, these other monitoring techniques could take the form of low-cost instruments, allowing a much greater density of monitoring sites. These could be used in short term campaigns or for permanent monitoring. The practical operation of such high-density networks will require research and development.
8. Priorities to improve urban air quality modelling include (i) developing emissions inventories, meteorology and topological information at spatial and temporal scales fine enough to reproduce variability found in urban situations; and (ii) validating real-life emissions data for road traffic under specific urban driving conditions.
9. In the 2020 timescale, the overarching aim should be better integration of air quality assessment (which includes ambient monitoring, remote monitoring, emissions data, and modelling) and health effects monitoring, addressing a strategy containing regulatory and supplementary aims as set out above.

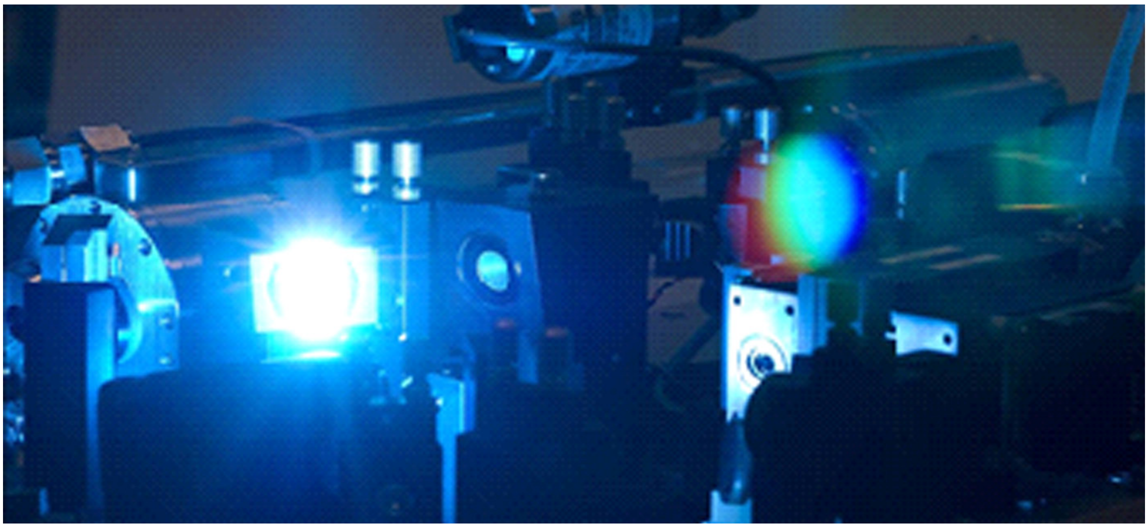
Monitoring Technologies

1. For regulated gaseous pollutants, there is no strong requirement to replace the reference methods for SO_2, O_3, CO and benzene. For NO_2, there are issues with the selectivity of the reference chemiluminescence instruments, which would be resolved using other techniques, e.g. cavity enhanced laser absorption spectroscopy instruments. However, the benefits of more accurate NO_2 measurements would be more scientific than regulatory, as the current methods are satisfactory for current regulations.

2. In the longer term, spectroscopic instruments based on, for example, multi-laser cavity ring down spectroscopy, offer potential benefits of high accuracy, compact multi-species gaseous pollutant instruments, and their development should be encouraged.

3. It would be beneficial to include ammonia among the gases routinely monitored in urban air, due to its impact on secondary aerosol formation.

4. Low cost gas sensors, such as those based on electrochemistry, have a large potential for enabling high spatial density monitoring which would be beneficial in urban areas. However, there is currently only preliminary evidence of their real world performance in terms of, for example, specificity and stability, the most promising evidence being for ozone sensors. Research in this area should be encouraged.
5. For the regulated particle metrics PM_{10} and $PM_{2.5}$, there are no automated technologies that are suitable as reference methods to replace the current manual reference methods without this leading to a significant change to the metrics. However, this is largely a consequence of these metrics being method-defined. The investigation of related but better-defined metrics, such as separate chemical components of the same size fractions, or their non-volatile components, is encouraged.
6. Although on-line methods for metals and polycyclic aromatic hydrocarbons are becoming available, there are no strong regulatory or health reasons for changing from the current manual reference methods. Automated methods with higher time resolution may be beneficial for scientific reasons, for example improvement of source attribution.
7. Black carbon (BC) is a strong candidate for future regulatory measurement, as a proxy for combustion products. It should be reported both as an optical absorption coefficient, and as a scaled concentration designed to be equivalent to elemental carbon (EC). This is because of the reliability of the measurement technology, and the importance of monitoring this major type of primary particle in terms of its relevance to both health effects and climatic radiative forcing.
8. Particle number concentration is a less strong candidate for regulatory measurement, because the number of particles in a given sample of air can change dramatically through coagulation, for example.
9. Instruments monitoring particle surface area concentration, based on diffusion charging, are promising as robust instruments monitoring a useful parameter relating to the physical properties of particles, although some of the difficulties associated with particle number concentration also apply.



10. Organic carbon (OC) and particle reactivity (such as Reactive Oxidative Species (ROS)) would be strong candidates for future measurement, due to early indications of health relevance. Research-based automated monitoring instruments have been developed, but network-ready instruments are not yet available.
11. Priority parameters for extended field trials are real time methods for ammonia, black carbon, particle surface area concentration, particle number concentration, organic carbon, ROS, and particle composition, specifically simplified Aerosol Mass Spectrometry for organic speciation, and automated analysers for elemental components.

Research Roadmap

The research roadmap is designed to present coordinated, focussed projects timed to maximise the use of the available expertise and to fit EU funding cycles within the Horizon 2020 programme.

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AirMonTech is an EU Coordination and Support Action compiling information to harmonize current air pollution monitoring techniques and to advise on future urban air monitoring technologies and strategy. AirMon Tech is gathering information on instrument performance, test results, equivalence demonstrations and standard operating procedures (SOPs), and processing them into specifically designed freely accessible database. Particular emphasis is placed on methods for real-time monitoring of gases, particles and particle-related proxy variables with relevance to human health. The extended focus of urban air quality monitoring is currently envisaged to lead to closer links of monitoring with exposure and possible health effects in the population.

From the nature of the proposed projects it is evident that defined Areas of Research and Monitoring of Air Quality (ARMAQs), in urban agglomerations, are needed to facilitate the development of future air quality monitoring. ARMAQs should be representative of the variations in Europe in, for example, climate, socio-economic factors, and genetics. The ARMAQs should be established as soon as is practical, through, for example, a specific Infrastructure call.

Six project topics and one supporting action are proposed below, comprising three projects in an earlier "data acquisition" phase, three in a later "integration" phase, with the dedicated supporting action linking these two phases.

"Data acquisition" phase
Instrumentation: leading to new and improved monitoring technologies and procedures for new and alternative metrics, relating to health and source monitoring.

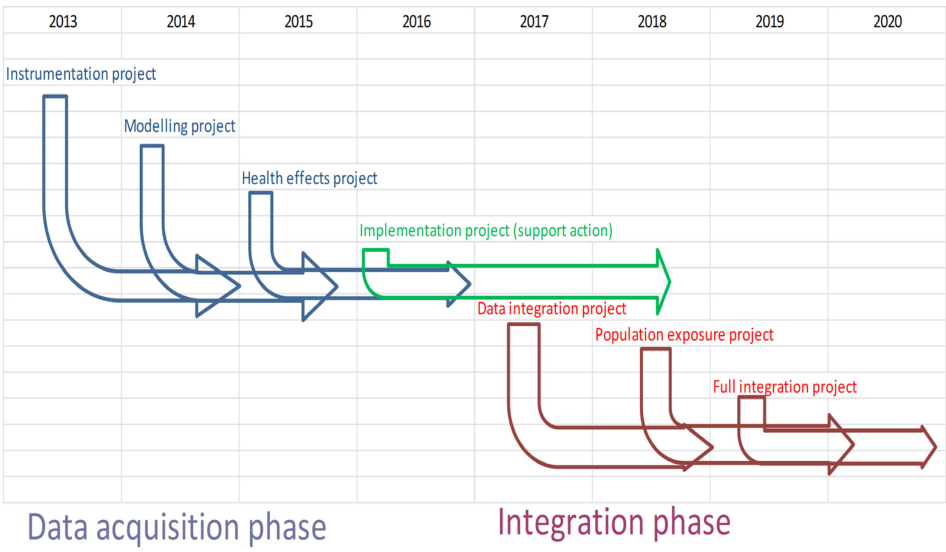
Modelling: leading to the development of a modelling and air quality data integration tool, including for alternative metrics.

Health effects: leading to robust methods to achieve (Europe-wide) routine health effect monitoring and health impact assessments.

Supporting action
Implementation: the development of implementation strategies of new AQ network designs, including for new metrics.

"Integration" phase
Data integration: leading to methods for optimised use of all monitoring data and modelling outputs, as developed in the Instrumentation and Modelling projects, to enable routine health, source, abatement and compliance assessment.

Population exposure: leading to methods to improve the estimation of population exposure from ambient concentrations and other data, making use of results from the Modelling and Health Effects projects.
Full integration: implemented integration of air quality and health monitoring, together with the supplementary scientific aims, at selected cities.
The proposed staggered start times of the projects are illustrated in the diagram below.
All projects are expected to last for about three years.



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