

Air4EU

Air Quality Assessment for Europe: from local to continental scale



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Final recommendation documents: Overview and recommendations

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LIST OF AIR4EU PARTNERS

Partic. no.	Participant name	Participant short name	Country
1	Netherlands Research Organisation	TNO	NL
2	Norsk Institut for Luftforskning	NILU	NO
3	Aristotle University Thessaloniki	AUT	GR
4	University of Stuttgart	IER	DE
5	University of Hertfordshire	UH	UK
6	Universidade de Aveiro	UAVR	PT
7	AIRPARIF	AIRPARIF	FR
8	Agenzia per i Trasporti Autoferrotramviari e la Mobilità del Comune di Roma S.p.A.	ATAC	IT
9	Environment Agency	EA	UK
10	City Development Authority of Prague	URM	CZ
11	Enveco	ENVECO	GR
12	Gemeentewerken Rotterdam	GW	NL
13	Milieudienst Rijnmond	DCMR	NL
14	City of Oslo, Public Health Authority	OPHA	NO

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LIST OF CONTRIBUTORS

Bruce Denby	NILU	NO
Steinar Larrsen	NILU	NO
Thomas Pregger	IER	DE
Sam Erik Walker	NILU	NO
Lia Fragkou	AUT	GR
Carlos Borrigo	UAVR	PT
Ana Margarida Costa	UAVR	PT
Ranjeet Sokhi	UH	UK
Ye Yu	UH	UK
John Douros	AUT	GR
Peter Builtjes	TNO	NL
Menno Keuken	TNO	NL
Hermann Heich	HC	DE

Overview and structure

Summary

This document is the final deliverable compiled within the FP6 project Air4EU as a guidance document providing recommendations of best methods for carrying out the spatial assessment of a number of regulated pollutants. This document provides recommendations on basic requirements, best practices and further scientific research in regard to this aim. Recommendations are provided for the various methodologies used to achieve spatial assessment including monitoring, modelling and methods for combining models and monitoring. A number of particular issues are also dealt with such as emissions and uncertainty analysis. The intended result of the spatial assessment and uncertainty analysis described here is the production of maps. The recommendations are intended as guidance for authorities involved in air quality assessment at city, national and European level. They are intended to aid good assessment practice and to highlight areas that require further development.

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1. Overview of Air4EU

The AIR4EU project addresses research on integrated air quality assessment by monitoring- and modelling methods at different temporal and the spatial scales local/hot spot, urban/agglomeration and regional/continental for regulated pollutants in Europe. In respect to air quality assessment, AIR4EU strengthens the links between research and policy, which has been recognised as a priority within the "Clean Air for Europe" (CAFE) programme.

The main aim of AIR4EU is to develop scientific sound and practical recommendations to integrate measuring and modelling techniques into consistent, comprehensive and cost-effective assessment methods for each of the spatial scales addressed. The outcomes of AIR4EU will directly benefit EU stakeholders including policy makers and city-, national- and regional users.

In AIR4EU researchers closely interact with authorities from seven major European cities (Oslo, Prague, London, Rotterdam, Paris, Rome and Athens) and a high-level Expert Group on the issue of appropriate AQ assessment. This close co-operation with stakeholders ensures the practical applicability of the recommendations developed.

This document has been prepared, as part of a series of documents, by the EU FP6 project, Air4EU (www.air4eu.nl). These documents outline recommendations for the assessment of a number of pollutants for a variety of applications with emphasis on spatial mapping. Emphasis is also given to the legislated pollutants to satisfy the requirements of EU directives.

1.1 Aim

The major aim of Air4EU is to provide recommendations on methodologies for carrying out the spatial assessment of air quality with emphasis on methodologies that combine monitoring and modelling.

1.2 Method

The recommendations provided in this document are based on extensive literature reviews, the direct experience of the researcher and city partners involved in the project, workshops, consultation with expert groups and a number of case studies carried out within the project. The process by which this final set of recommendation documents has been arrived at can be found in the following Air4EU deliverable documents:

- Requirements and needs for AQ assessment (D2.1)
- Review of current assessment methods (D3.1, D4.1, D5.1)
- First set of recommendations (D3.2, D4.2, D5.2)
- Case studies addressing selected recommendations (D6.1, D7.1, D7.2)
- Final recommendation documents (D6.2)

In addition to these major deliverable documents a number of cross-cutting issues have been addressed that cover all scales and applications. More detail on these specific issues can be found in the 5 following milestone reports and the reader is referred to these when seeking more detailed background information.

- Emission & Data needs (M6.4)
- Uncertainty of Models & Monitoring (M6.5)
- Representativeness of Models & Monitoring (M6.6)
- Scale Interactions (M6.7)
- Data Assimilation (M6.8)

2. Scope of the recommendations

There are any number of recommendations possible for a wide variety of assessment applications. Recommendations can be aimed at different types or levels of assessment, at different methods for assessment, at different scales and for different pollutants. During the course of the Air4EU project, and built into the initial planning, a series of steps were taken to identify the most relevant application and assessment areas. This was based on input from the city partners and from consultation within and external to the project. Identification of these application areas, as well as city and European authorities needs, were formulated and documented in the project deliverable D2.1- "Policy framework and requirement analysis"

To address these requirements and needs with useful recommendations, a structure was required that would in an organized fashion take into account and group the many possible recommendations into a practical and accessible document. The majority of recommendations were oriented towards the major goal of Air4EU, that being recommended methodologies for combining monitoring and modelling for spatial mapping.

As a first step in the process of formulating recommendations a broad scope was set in which a number of application areas, levels of assessment, scales, pollutants and methodologies were defined. The following listing indicates the total scope of the recommendations, which required further prioritised and refinement.

2.1 Application areas

A number of application areas were defined. The first and foremost of these is the application for:

1. Spatial assessment for air quality

This major application area entailed the mapping of both concentrations and exceedances to limit values.

In addition to this a number of other application areas were defined. These are:

2. Assessment of source contributions
3. Assessment and analysis of trends
4. Assessment of population exposure
5. Information to the public
6. Scenario calculations

2.2 Level of assessment

Since the level of required assessment varies from application to application and the capacity and experience varies from city to city, several levels of assessment were also possible. These included:

1. Typical European assessment practices.
2. A lower quality level, corresponding to 'Improvements of less advanced assessment practices'.
3. A higher quality level, corresponding to 'Best practice'.
4. Further research recommendations

In general the recommendations that are to come from Air4EU were intended to highlight best practices but the need for both basic requirements and further research was also recognised.

2.3 Scales

The spatial scale of the assessment was, from the inception of the project, an important distinguishing aspect of any modelling or monitoring assessment. Models historically deal with a limited spatial scale and monitoring practices and network design vary due to the scale of required assessment. The 3 scales identified are:

1. Local/hotspot scale (meters to 1 km)
2. Urban/agglomerate scale (1 to 300 km)
3. Regional scale (50 km to continental)

2.4 Pollutants

There are a large number of pollutants that can be assessed. Air4EU concentrated on the pollutants that are regulated, i.e. contained in the daughter directives. These include:

1. PM₁₀
2. PM_{2.5}
3. NO₂
4. O₃
5. SO₂
6. Benzene
7. PAH
8. Heavy metals
9. CO

Of these the pollutants that are responsible for the most number of exceedances were to be prioritised, which included PM, NO₂ and O₃.

2.5 Methods

The different methods used to achieve the assessment were addressed. As an initial starting point the two most used methods, and their combination, were identified. These being:

1. Monitoring
2. Modelling
3. Combining monitoring and modelling

Further to these methods a number of other aspects of importance were identified at the outset of the project as being cross-cutting issues that were common to these methods. These included:

4. Emissions
5. Uncertainty analysis of monitoring and modelling
6. Representativeness of monitoring and modelling
7. Scale interactions
8. Data assimilation

Each of the above methods consists of a number of aspects, e.g. chemistry, meteorology and dispersion are different aspects of modelling. For each of these aspects a number of individual recommendations could be made at different levels, at different scales, for different compounds and for different applications. Some recommendations will be common to a number of different areas and some will be very specific. Prioritising and organizing this into a coherent whole requires a suitable structure, which is outlined in the following section.

3. Structure of the recommendation documents

Given the large range of possible applications, scales, levels, compounds and methods for assessment, a prioritisation and organisation was required to present the large set of individual recommendations. The prioritisation process took place through discussions within the Air4EU consortium and questionnaires provided explicitly by the city, resulting in the deliverables D2.1- "Policy framework and requirement analysis" and D6.1 – "Case study protocol" ([Expand on this properly with links](#)). It was decided to provide a limited number of recommendation topics, within which a number of relevant individual recommendations would subside. Such a topic should reflect the user requirements for assessment and thus reflect the application. For example a topic would be: 'How to spatially assess NO₂ in an urban area'. Such a topic is highly relevant to cities that wish to provide spatial assessments for legislative purposes or who would like to carry out population exposure estimates. The recommendation topic would then examine the various methods for carrying out assessment and treat the different levels of assessment as outlined above in Chapter 2.

The following structure thus reflects the prioritisation and organisation process.

1. **First level:** Recommendation topic
2. **Second level:** Methods applied for the assessment
3. **Third level:** The required level or quality of assessment
4. **Fourth level:** *The individual recommendations*

3.1 The recommendation topics

It is possible to create a long list of recommendations topics. Such a list would reflect the overriding variations in applications, pollutants and scales. As such it would consist of, according to the lists provided in chapter 2 above, $6 \times 9 \times 3 = 162$ different topics. Some make sense, for example 'Spatial assessment of NO₂ in urban areas' and some do not, e.g. 'Spatial assessment of CO on regional scales'. Some topics may be pooled, e.g. 'Trend analysis' is a general topic that can be addressed in a similar fashion for all pollutants and scales. Some of the methods or issues may be considered to be of such importance to users that they can become their own topic, e.g. 'Source apportionment in urban areas'.

As a result of reflection and discussion within the Air4EU consortium the following set of 12 recommendation topics have been identified. Each of these recommendation topics is dealt with sequentially within this report. The first set of recommendation topics reflects the application of spatial assessment chiefly for compliance with the daughter directives and the second reflects more specific topics related directly to city needs.

Spatial assessment topics

- I Spatial assessment of NO₂ in urban areas
- II Spatial assessment of PM in urban areas
- III Spatial assessment of O₃ in urban areas
- IV Assessment of NO₂ at hotspots
- V Assessment of PM at hotspots
- VI Spatial assessment of O₃ for Europe
- VII Spatial assessment of PM for Europe

Specific assessment topics

- VIII Assessment of source contributions in urban areas
- IX Trend analysis

- X Scenarios
- XI Assessment of PM emissions from traffic induced suspension of road dust
- XII Assessment of PM emissions from 2 wheelers

3.2 Methods for assessment

The methods, and related issues, used for assessment will vary from topic to topic. The list of methods and issues for spatial assessment will include the following:

- o *Monitoring*
- o *Modelling*
- o *Combining models and monitoring*
- o *Emissions*
- o *Uncertainty analysis*

Within this context the already mentioned cross-cutting issues such as scale interactions and representativeness are contained within the *modelling* and *uncertainty* methods sections respectively. Other topics, such as trend analysis or PM emissions from suspension, will use slightly different methods and this will be reflected in their individual methods structure.

Each of these methods will contain a number of aspects, for example methods for assessment using *modelling* would include the following:

- General model types and requirements
- Meteorology
- Dispersion and transport
- Chemistry and aerosol processes
- Rural background contribution
- Interactions between modelling scales

3.3 Levels of assessment

Having established the above methods and aspects, recommendations are then made on these. These are divided into 3 levels of complexity being:

- a) *Basic requirements*
- b) *Best practice recommendations*
- c) *Scientific recommendations*

The first level, *basic requirements*, reflect recommendations aimed at fulfilling the minimum requirements in reporting for the regulated pollutants. It also reflects typical current practices and starting points for cities engaging in air quality assessment.

The second level, *best practises*, reflects the state of the art in achievable methods for city authorities and institutes already engaged in air quality assessment. This typically involves more than just basic reporting requirements but also points towards improved understanding of the air quality situation in the assessment area.

The final level, *research recommendations*, points to further research requirements required to improve the spatial assessment of air quality. These may be general in nature but sometimes quite specific.

4. Case studies of recommendations

In order to test, validate and improve recommendations a number of case studies have been organised between the research partners and the city partners in Air4EU. The following table lists the various case studies undertaken:

Case study	Descriptive name
Rotterdam I	Trend analysis of pollutants for 1995-2005 for Rotterdam
Rotterdam II	Assessment of regional background contributions for Rotterdam during exceedance periods (PM ₁₀)
Rome	Review of AQ assessment for PM ₁₀ : emphasis on 2 wheeler emissions
Oslo I	Data assimilation on the urban scale for Oslo
Oslo II	Data assimilation in open line source modelling: parameter and uncertainty estimation
Oslo III	Source apportionment: inverse modelling of PM emissions in an urban area
Prague I	Data assimilation on the urban scale for Prague
Prague II	Statistical combination of modelling and monitoring on the urban scale
Paris	Review of data assimilation methods
London I	Traffic management impact
SE England	Impact of stack emissions in urban scale modelling
London III	Uncertainty in AQ assessment in London
Athens	Assessment of PM levels and contributions in the Athens region
Europe I	Data assimilation with a regional scale model: homogenous regional background for city assessment
Europe II	Statistical combination of modelling and monitoring on the European scale
Berlin	Assessment of PM ₁₀ and NO ₂ levels in Berlin

Each of these case studies was developed to address one or more of the recommendations provided by Air4EU. An overview of these case studies can be found in the deliverable document D7.2 ([link](#)) and each of the individual case studies is reported in the deliverable document D7.1 ([link](#)).

At relevant points within the recommendation topics throughout this report, summaries of the findings from the case studies will be given. These are aimed at providing practical examples of 'best practice' methods

5. Mapping

Spatial assessment leads naturally to the requirements of mapping. To best demonstrate the types of maps that can be produced for assessment and to demonstrate the improvement obtained through combining monitoring and modelling a GIS based web tool has been developed within Air4EU

<http://dev0.nilu.no/users/ral/prosjekter/air4eu/index.cfm?fa=login.main>

(Userid: air4eu; Password: niluair2006)

This web tool allows a range of maps, of different scales and using different methods, to be displayed in an interactive fashion. Maps are homogenised so that direct comparisons between the different methods can be made, as well as an assessment of the differences between maps at varying scales and in varying locations.

The maps contained in the web portal are chiefly the result of Air4EU case studies. Essential to the maps is the assessment of uncertainty and so in addition to every map produced a map showing the uncertainty in the assessment map is also provided.

Some expanding needed here