

Air4EU

Air Quality Assessment for Europe: from local to continental scale



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Final recommendation documents

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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

Air4EU (www.air4eu.nl) is an EU FP6 project that addresses research on integrated air quality assessment through monitoring and modelling methods. It deals with different temporal and spatial scales (local/hot spot, urban/agglomeration and regional/continental) and with a number of 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 scientifically 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 air quality assessment. This close co-operation with stakeholders ensures the practical applicability of the recommendations developed.

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.

This Air4EU document has been prepared to fulfil this aim and consists of a series of documents (Air4EU – D6.2, Part I - IV) that outline recommendations for carrying out the spatial assessment of a number of pollutants. Priority is given to the legislated pollutants to satisfy the requirements of the EU directives.

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 following 5 milestone reports and the reader is referred to these when seeking more detailed background information.

- Emissions & Data needs (M1)

- Uncertainty of Models & Monitoring (M2)
- Representativeness of Models & Monitoring (M3)
- Scale Interactions (M4)
- Data Assimilation (M5)

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 “Policy framework and requirement analysis” (Air4EU - D2.1).

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 prioritisation 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 extent and resolved spatial scale, and monitoring practices and network design vary due to the scale of the required assessment. The 3 scales, and their spatial resolution and extent, are identified as:

1. Local/hotspot scale (Resolution: 1 - 100 m; extent: 1 km)
2. Urban/agglomerate scale (Resolution: 1 - 10 km; extent: 300 km)
3. Regional scale (Resolution: 10 - 50 km; extent: 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, or running through them, a number of other issues of importance were identified at the outset of the project as being 'cross-cutting', i.e. 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 elements, e.g. chemistry and meteorology are different elements of modelling, and for each of these in turn 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 answers to questionnaires provided by the city partners, resulting in the deliverables “Policy framework and requirement analysis” (Air4EU – D2.1) and “Protocols for implementation of case studies” (Air4EU – D6.1). 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

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. ‘Population exposure’ is a general topic that can be addressed in a similar fashion for many pollutants and scales.

As a result of reflection and discussion within the Air4EU consortium the following set of 3 recommendation topics have been defined. This small number of topics reflects the overlap between the various aspects of spatial assessment, which allows extensive pooling of topics to be carried out to avoid unnecessary repetition. The set of recommendation topics reflects chiefly the application of spatial assessment for compliance with the daughter directives but also touches on a number of the other application areas such as population exposure and source contributions.

Spatial assessment topics

II Spatial assessment of PM, NO₂ and O₃ in urban areas

III Assessment of PM and NO₂ at local/hotspot scale

IV Spatial assessment of PM and O₃ at regional/continental scale

The first recommendation topic, on spatial assessment in urban areas (Part II, this current summary being Part I), is the most comprehensive and immediately relevant for city users.

3.2 Methods for assessment

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

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

Within this context the already mentioned cross-cutting issues such as emissions, scale interactions and representativeness will be contained within the *modelling* and *uncertainty* methods sections.

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

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

3.3 Levels of assessment

Having established the above methods, recommendations are then made and divided into 3 levels of complexity:

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

The first level, *basic requirements*, reflects 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 required to improve the spatial assessment of air quality. These may be general in nature but sometimes quite specific.

3.4 Referencing

Reference is made throughout the recommendation documents to a number of other related Air4EU reports. An overview can be found in the Air4EU reference section at the end of this document. These reports include background reports leading up to this final set of recommendations, the individual and summary case study reports, reports on the mapping tool and a number of cross cutting issue milestone reports covering specific issues.

4. Case studies of recommendations

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

Case study	Descriptive name	City/Region
1	Trend analysis of NO ₂ /NO _x and PM ₁₀ exceedances of daily limit values in Rotterdam	Rotterdam
2	Assessment of non-exhaust PM by road traffic in urban areas	Rotterdam, Rome, Oslo, London
3	Model and observation uncertainty analysis towards data assimilation on the urban scale	Oslo
4	Data assimilation in open line source modelling	Oslo
5	Source apportionment of particulate matter using dispersion and receptor modelling	Oslo
6	Basic data assimilation: application to the urban scale	Prague
7	Comparisons of data assimilation methods at urban scale in Paris	Paris
8	Traffic management impact in London	London
9	Assessment of stationary source contribution to surface pollutant concentrations using a 3-D Eulerian Air Quality Model	SE England
10	Uncertainty in AQ assessment in London	London
11	Assessment of PM levels and contributions in the Athens region	Athens
12	Data assimilation with a regional scale model: homogenous regional background for city assessment	Europe
13	Basic data assimilation: application to the European scale	Europe
14	Berlin case study report: assessment of modelling uncertainties	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 'Case study

overview' (Air4EU - D7.2) and each of the individual case studies is reported in the deliverable documents (Air4EU - D7.1; 1 to 14).

At relevant points throughout the recommendation documents, summaries of the findings from the case studies will be given. These are aimed at providing practical examples of 'best practice' methods as well as 'research needs'.

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 (Air4EU – D7.3 and D7.4).

www.air4eumaps.info

This web tool allows a range of maps, at 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, for a number of the maps produced, maps showing the uncertainty in the assessment are also provided.

Air4EU references

All deliverables and reports from Air4EU can be found at:

http://www.air4eu.nl/reports_products.html

Background reports

Air4EU – D1.1: Inception report

Air4EU – D1.2: Mid term assessment report

Air4EU – D1.3: Final report

Air4EU – D2.1: Policy framework and requirements analysis report

Air4EU – D3.1: Review of monitoring and modelling methods at hotspot/local scale

Air4EU – D3.2: First recommendations for air quality assessment at hotspot/local scale

Air4EU – D4.1: Review of monitoring and modelling methods at urban/agglomeration scale

Air4EU – D4.2: First recommendations for air quality assessment at urban/agglomeration scale

Air4EU – D5.1: Review of monitoring and modelling methods at regional/continental scale

Air4EU – D5.2: First recommendations for air quality assessment at regional/continental scale

Recommendation reports

Air4EU – D6.2: Final recommendation documents

Part I: Overview and structure

Part II: Spatial assessment in urban areas

Part III: Spatial assessment at local/hot spot scale

Part IV: Spatial assessment at regional/continental scale

Case study and mapping reports

- Air4EU – CS D7.1.1: Trend analysis of NO₂/NO_x and PM₁₀ exceedances of daily limit values in Rotterdam
- Air4EU – CS D7.1.2: Assessment of non-exhaust PM by road traffic in urban areas
- Air4EU – CS D7.1.3: Model and observation uncertainty analysis towards data assimilation on the urban scale
- Air4EU – CS D7.1.4: Data assimilation in open line source modelling
- Air4EU – CS D7.1.5: Source apportionment of particulate matter using dispersion and receptor modelling
- Air4EU – CS D7.1.6: Basic data assimilation: application to the urban scale
- Air4EU – CS D7.1.7: Comparisons of data assimilation methods at urban scale in Paris
- Air4EU – CS D7.1.8: Traffic management impact in London
- Air4EU – CS D7.1.9: Assessment of stationary source contribution to surface pollutant concentrations using a 3-D Eulerian Air Quality Model
- Air4EU – CS D7.1.10: Uncertainty in AQ assessment in London
- Air4EU – CS D7.1.11: Assessment of PM levels and contributions in the Athens region
- Air4EU – CS D7.1.12: Data assimilation with a regional scale model: homogenous regional background for city assessment
- Air4EU – CS D7.1.13: Basic data assimilation: application to the European scale
- Air4EU – CS D7.1.14: Berlin case study report: assessment of modelling uncertainties

Air4EU – D6.1: Case study protocol

Air4EU – D7.2: Case study overview

Air4EU – D7.3: Air4EU mapping tool: description and user guide

Air4EU – D7.4: Air4EU mapping tool: URL: www.air4eumaps.info

Cross cutting issue milestone reports

Air4EU – M1: Emissions and data needs

Air4EU – M2: Uncertainties of models and monitoring

Air4EU – M3: Representativeness of model outputs and monitoring data

Air4EU – M4: Scale interactions

Air4EU – M5: Data assimilation