Proposed Intercomparison Exercise: Spatial Representativeness of Air Quality Monitoring Stations

Oliver Kracht

European Commission – Joint Research Centre

Fernando Martín, José Luís Santiago, Laura García

CIEMAT, SPAIN

FAIRMODE
Forum for air quality modelling in Europe

Fairmode Plenary Meeting
12th and 13th February 2015

Baveno - Italy

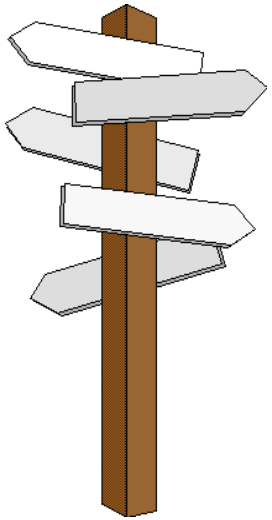
From the JRC- AQUILA Position Paper "SCREAM":

[… the issue of spatial representativeness …] will be further discussed in the framework of the collaboration between AQUILA and FAIRMODE. The concept of area of representativeness could further be worked out within the FAIRMODE modelling and monitoring work package that is currently being drafted as one of the aspects of the harmonization of modelling and monitoring activities in close collaboration with AQUILA.

European Commission

FAIRMODE proposed 2014 – 2016 roadmap:

Cross-cutting activity on spatial representativeness



- **Support** the development of the **MQO**: a methodology to assess the spatial representativeness (SR) of air quality measurements
- Evaluate the feasibility of **methodological comparisons on SR**, preferably on shared datasets. The methodological diversity of the different approaches might impose significant challenges in this regard.

European Commission

Outline

1) Introduction
2) Aims and Scope of the Intercomparison Exercise
3) Work Plan and Timeline
4) Feasibility Study (F. Martín, J. L. Santiago, L. García - CIEMAT)
5) Outlook
6) Comments and Discussion (after 2nd presentation)

Introduction

Spatial representativeness of air quality monitoring stations has been investigated and discussed intensively in the past within FAIRMODE and AQUILA.

No well-established procedure for assessing spatial representativeness has been identified so far.

No unified agreement to address this complex problem in scientific literature.

FAIRMODE wants to make progress in the assessment procedure of spatial representativeness.

Introduction

Within FAIRMODE and AQUILA we are proposing the organisation of an **intercomparison exercise** of methods for the assessment of the **spatial representativeness** of monitoring sites.

The main objective will be to explore the strengths and weaknesses of the different contemporary approaches by applying them to a jointly used example case study.

We expect that

- The outcomes of the proposed intercomparison exercise will support future endeavours towards a **harmonized methodological framework** to facilitate the reporting of spatial representativeness by the Member States.
- Increasing the **consistency** and the **transparency** of information will serve as in important factor in **motivating future reporting on spatial representativeness** within the established exchange of information.

Work Plan

The exercise shall:

- Be executed by different groups, but on the same shared dataset.
- Cover as much as possible of the total variety and diversity of procedures which are in use today - ranging from methods with moderate complexity, used for pragmatic purposes, to those which involve higher levels of data requirements and computational efforts.

It could be necessary to accept that the pool of investigated methods will not necessarily share a strictly unique definition of spatial representativeness.

We anticipate a **considerable variety** of different types of spatial representativeness methods:

1. Methods immediately **based on an estimate of the spatial distribution of pollutants** combined with a set of statistical similarity criteria

   a. Concentration fields derived from **observations**

   b. Concentration fields derived from air quality **modelling**

2. Methods **based on pollutant proxies and / or surrogate data** (e.g. emissions, population density, land use) in combination with a set of statistical similarity criteria

3. Methods **linked to the classification** of stations or sites

Range of applications

Methods for estimating the spatial representativeness find their practical application in different fields and in different contexts:

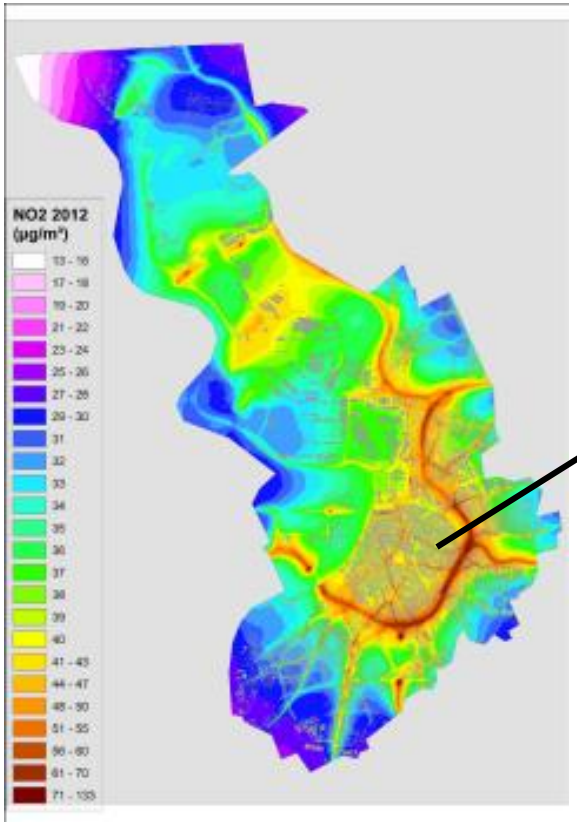
- station siting and network design
- station classification
- data assimilation
- model evaluation
- air quality reporting
- reporting of exceedances
- population exposure studies

Outputs (SR results) may range from:

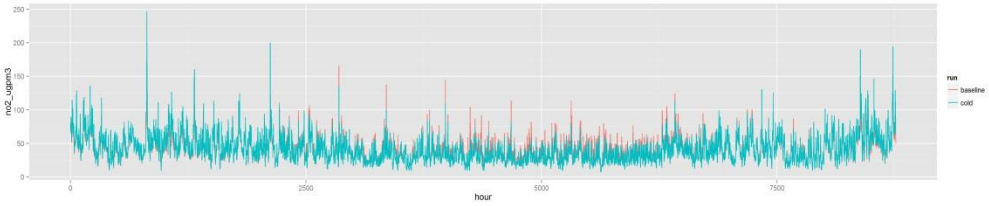
1. Detailed **geospatial descriptions** of the SR area (spatial polygons, maps …)
2. Quantifications by **simplified geometric concepts** (radius of the SR area, length of street segment …)
3. **Semi-quantitative estimates** (scale or the order of magnitude of the SR area)
4. An estimated spatial variance or other **statistical parameters**
5. Characterisations by surrogate categorical attributes (different types of **station classification schemes**)
6. Other means of reporting, including **qualitative descriptions**

Suggestions for Shared Datasets

Example: 2012 IFDM Model results for Antwerp



- Annual average concentration, res≈20m (irregular grid)
- Hourly time series on previously specified points, e.g. monitoring stations, sampler positions. (8760 values, 140KB/pt)



Suggestions for Shared Datasets

Example: 2012 Model results for Antwerp

- Gaussian dispersion model (IFDM)
- Contribution of all sources is calculated for each receptor point for every hour of the year.
- Hourly background concentration from Chemical Transport Model (CTM) or spatial interpolation between measurement stations.
- Point, line and surface sources from industry / traffic / domestic heating
- Building geometry for street canyon calculations
- Weather (temperature, wind speed and direction)

- Population density is not a model input
- Land use is not a direct model input; Land use is however indirectly introduced via the background concentration inputs

Schedule and Mode of Operation

A. <u>Feasibility study and preparations</u>

1. Timeframe: October 2014 until June 2015
2. Organisation:
   - Mainly the hands of CIEMAT (F. Martin & J. L. Santiago Del Rio)
   - JRC functions as a coordinator

B. <u>Intercomparison exercise on shared datasets</u>

1. Timeframe: Starting ca beginning of 2016
2. Organisation:
   - Coordinated by JRC
   - Participants from different Member States and organizations

Scope of the Feasibility Study

- Evaluate the feasibility of the actual methodological intercomparison study
- Identification of candidate methods
- Requirements on shared datasets
- Assessment of the comparability of the different types of spatial representativeness results
- Investigate about the best way to compare the outcomes of the different spatial representativeness methods
- Identify the limitations to be expected

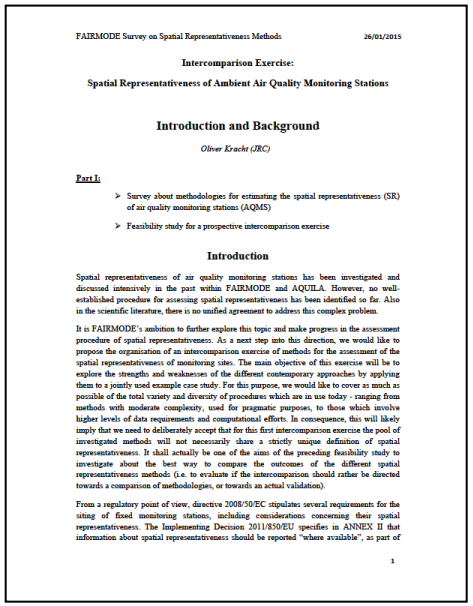
IC Exercise

European Commission

Ongoing Survey

Feasibility Study and Survey

Questionnaires distributed by end of January



FAIRMODE Survey on Spatial Representativeness Methods 26/01/2015

Intercomparison Exercise:

Spatial Representativeness of Ambient Air Quality Monitoring Stations

Introduction and Background

Oliver Kracht (JRC)

Part I:

- Survey about methodologies for estimating the spatial representativeness (SR) of air quality monitoring stations (AQMS)
- Feasibility study for a prospective intercomparison exercise

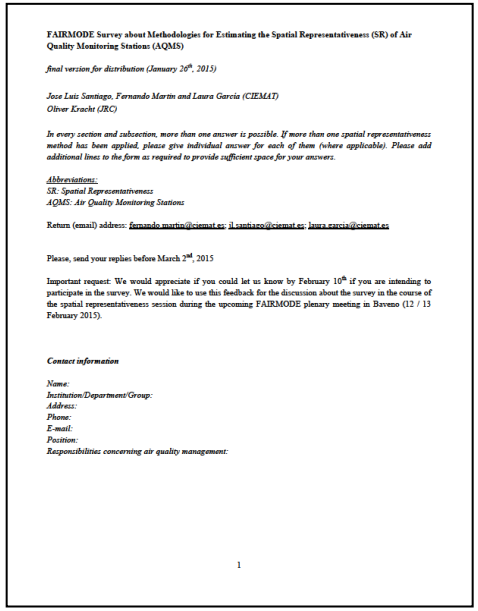
Introduction

Spatial representativeness of air quality monitoring stations has been investigated and discussed intensively in the past within FAIRMODE and AQUILA. However, no well-established procedure for assessing spatial representativeness has been identified so far. Also in the scientific literature, there is no unified agreement to address this complex problem.

It is FAIRMODE's ambition to further explore this topic and make progress in the assessment procedure of spatial representativeness. As a next step into this direction, we would like to propose the organization of an intercomparison exercise of methods for the assessment of the spatial representativeness of monitoring sites. The main objective of this exercise will be to explore the strengths and weaknesses of the different contemporary approaches by applying them to a jointly used example case study. For this purpose, we would like to cover as much as possible of the total variety and diversity of procedures which are in use today - ranging from methods with moderate complexity, used for pragmatic purposes, to those which involve higher levels of data requirements and computational efforts. In consequence, this will likely imply that we need to deliberately accept that for this first intercomparison exercise the pool of investigated methods will not necessarily share a strictly unique definition of spatial representativeness. It shall actually be one of the aims of the preceding feasibility study to investigate about the best way to compare the outcomes of the different spatial representativeness methods (i.e. to evaluate if the intercomparison should rather be directed towards a comparison of methodologies, or towards an actual validation).

From a regulatory point of view, directive 2008/50/EC stipulates several requirements for the siting of fixed monitoring stations, including considerations concerning their spatial representativeness. The Implementing Decision 2011/850/EU specifies in ANNEX II that information about spatial representativeness should be reported "where available", as part of

1



FAIRMODE Survey about Methodologies for Estimating the Spatial Representativeness (SR) of Air Quality Monitoring Stations (AQMS)

final version for distribution (January 26th, 2015)

Jose Luis Santiago, Fernando Martin and Laura Garcia (CIEMAT)
Oliver Kracht (JRC)

In every section and subsection, more than one answer is possible. If more than one spatial representativeness method has been applied, please give individual answer for each of them (where applicable). Please add additional lines to the form as required to provide sufficient space for your answers.

Abbreviations:
SR: Spatial Representativeness
AQMS: Air Quality Monitoring Stations

Return (email) address: fernando.martin@ciemat.es; jl.santiago@ciemat.es; laura.garcia@ciemat.es

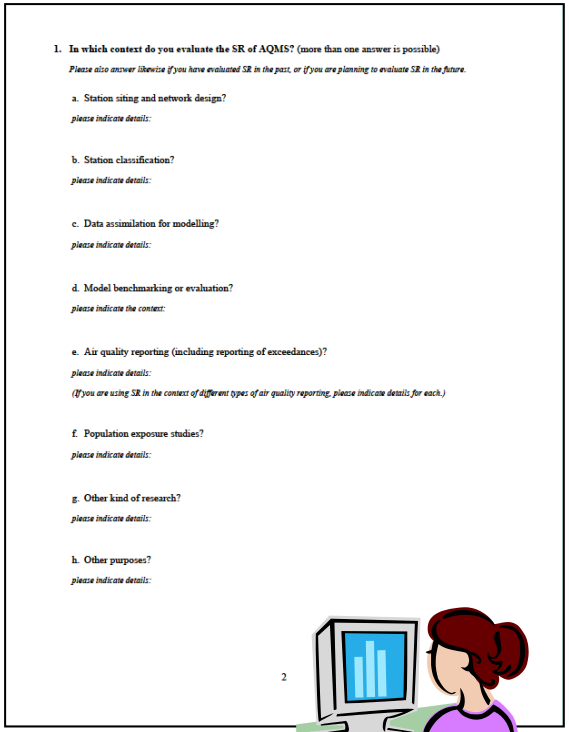
Please, send your replies before March 2nd, 2015

Important request: We would appreciate if you could let us know by February 10th if you are intending to participate in the survey. We would like to use this feedback for the discussion about the survey in the course of the spatial representativeness session during the upcoming FAIRMODE plenary meeting in Baveno (12 / 13 February 2015).

Contact information

Name:
Institution/Department/Group:
Address:
Phone:
E-mail:
Position:
Responsibilities concerning air quality management:

1



1. **In which context do you evaluate the SR of AQMS?** (more than one answer is possible)

Please also answer likewise if you have evaluated SR in the past, or if you are planning to evaluate SR in the future.

a. Station siting and network design?

please indicate details:

b. Station classification?

please indicate details:

c. Data assimilation for modelling?

please indicate details:

d. Model benchmarking or evaluation?

please indicate the context:

e. Air quality reporting (including reporting of exceedances)?

please indicate details:

(If you are using SR in the context of different types of air quality reporting, please indicate details for each.)

f. Population exposure studies?

please indicate details:

g. Other kind of research?

please indicate details:

h. Other purposes?

please indicate details:

2

Joint Research Centre

Schedule and Mode of Operation (2): Outlook

In more detail, four working-steps have been scheduled:

1. Feasibility study (October 2014 - June 2015)
2. Conceptualisation of the intercomparison exercise and preparation of datasets (September 2015 until December 2015)
3. Conducting the actual intercomparison exercise (January 2016 until June 2016)
4. Evaluating the outcomes of the exercise: (July 2016 until December 2016)

Important Dates

Jan. 2015

- Distribution of Questionnaires

Feb. 2015

- FAIRMODE plenary meeting in Baveno (IT)
  - Presentation of the survey and of first outcomes

June 2015

- Final reporting on the results of the feasibility study
  - Identification of candidate methods and possible participants
  - Suggest possible means and techniques for the intercomparison

Summer 2015

- FAIRMODE technical meeting
  - Detailed discussion on means and operation (datasets, timeframe …)

Jan. 2016

- Launching of the actual intercomparison exercise

Thank you for your attention!

Now more details will follow about the currently ongoing survey and feasibility study:

Questions and Suggestions?

Some open questions for discussion

- How can outputs from different types of SR methodologies be compared?
- Are estimates based on different definitions of SR comparable at all?
- Do we need to agree to an unique definition of SR beforehand?
- Do we need to perform separate intercomparisons by different groups of methodologies / by different SR definitions / by different SR applications?

The outcomes of the preceding survey should tell us about

- anticipated number of participants (volunteers)
- expected range and variety of participating methodologies

Based on this (and other inputs), we will then be able to evaluate if the intercomparison should rather be directed

- Towards a comparison of methodologies, or
- Towards an actual validation

Some open questions for discussion

- You would like to participate. Does the timeline suit your own boundary conditions?

- In order to best cover the range of different spatial representativeness applications, it could be favourable to assign a set of different task to be conducted on the same dataset (city of Antwerp). Example given, we could define 6 different tasks / locations, like:
  - Ozone in summer time at station X
  - NO_2 in winter time at station Y
  - etc.

  Would you have the time and capacities to treat such set of tasks within one exercise?