FAIRMODE & AQUILA

FAIRMODE Forum for air quality modelling in Europe

Air Quality Reference Laboratories

European Commission

Intercomparison Exercise on Spatial Representativeness

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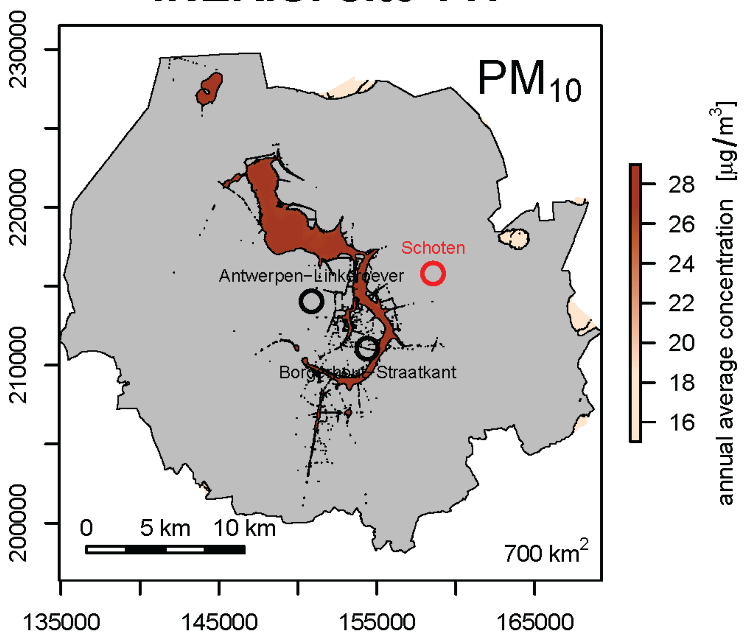
Introduction

We are presenting the outcomes of the FAIRMODE & AQUILA **intercomparison exercise (IE)** on the **spatial representativeness (SR)** of **air quality monitoring stations (AQMS)**. Based on a shared dataset comprising modelling data (gridded annual means and time series for 341 virtual receptor points) and auxiliary information for the city of **Antwerp**, 11 teams from 10 different countries provided their SR estimates for PM_{10}, NO_2 and O_3 at one traffic site and two urban background sites. All **participants worked by their own selected methods**, and by using those parts of the data that they would normally require in their own applications. We are demonstrating 9 out of 11 **SR estimates (grey colored areas)** that have been submitted for PM_{10} at the urban background station Schoten (v17).

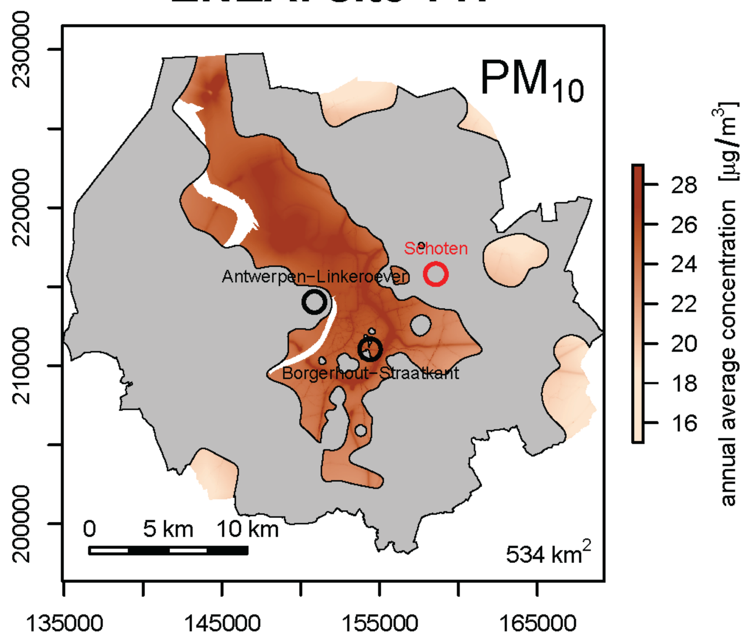
SR maps not shown for organizational reasons: **CIEMAT** (used a CFD approach, but did not work on station v17), **RIVMM** (applied principal component analysis).

INERIS: site v17



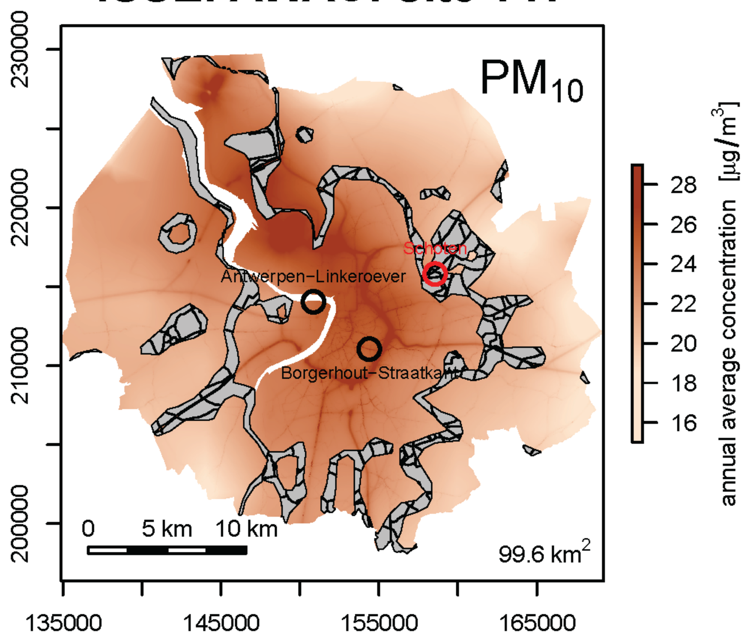
INERIS worked on the annual mean model outputs by first preparing a spatial estimate of concentrations (kriging with external drift; secondary variables: emissions and distance to roads) and concentration uncertainties (from kriging error standard deviations). Finally, the SR area is delimitated based on a combined criterion for maximum permissible concentration deviations (30% for PM_{10}) and maximum permissible statistical risk (15% risk of wrongly including a point in the SR area).

ENEA: site v17



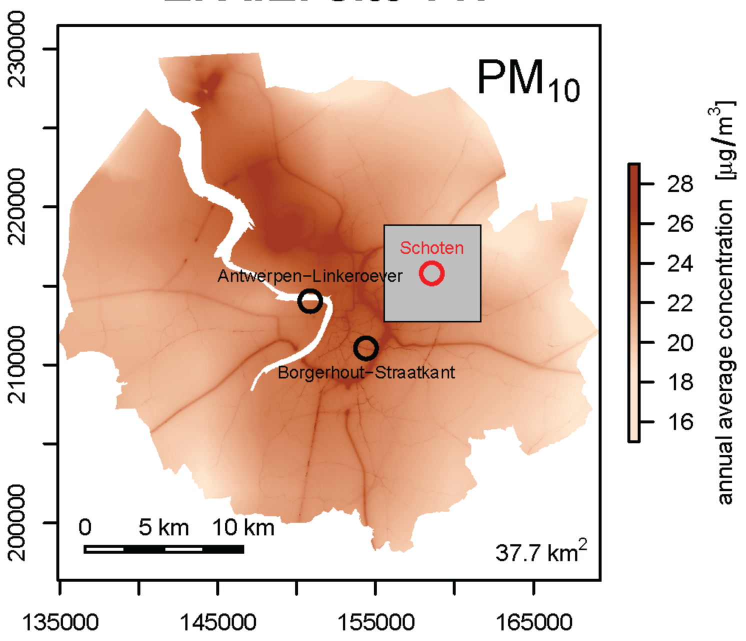
ENEA based calculations on the Concentration Similarity Frequency (CSF) function, which recursively relates time series of modelled concentration fields to the AQMS. For every time step, relative concentration differences between the AQMS and all 341 receptor points are compared with a 20% threshold, in order to assess the condition of similarity. Finally, the SR area is delimited as the area where the similarity condition is fulfilled >90% of the time on a yearly basis.

ISSEPAWAC: site v17



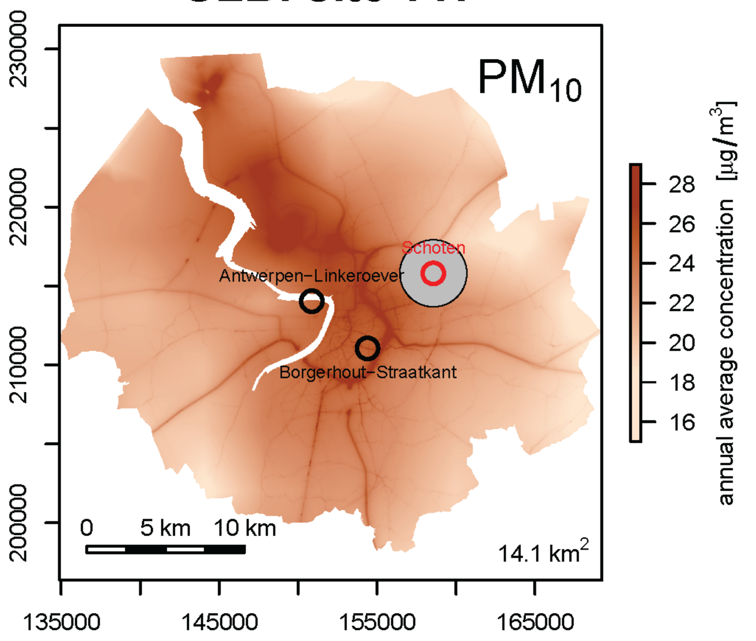
The methods used by **ISSEeP & AwAC** are based on emission data. For background sites, total emissions are first disaggregated into 100x100 m² cells, then re-aggregated through a spatially moving sum with a circular window of radius 1 km. The SR area extends to all points with total emission values similar to those at the AQMS ± a tolerance value (0.020 $gs^{-1}km^{-2}$ for PM_{10} - set subjectively based on indications from the literature.

EPAIE: site v17



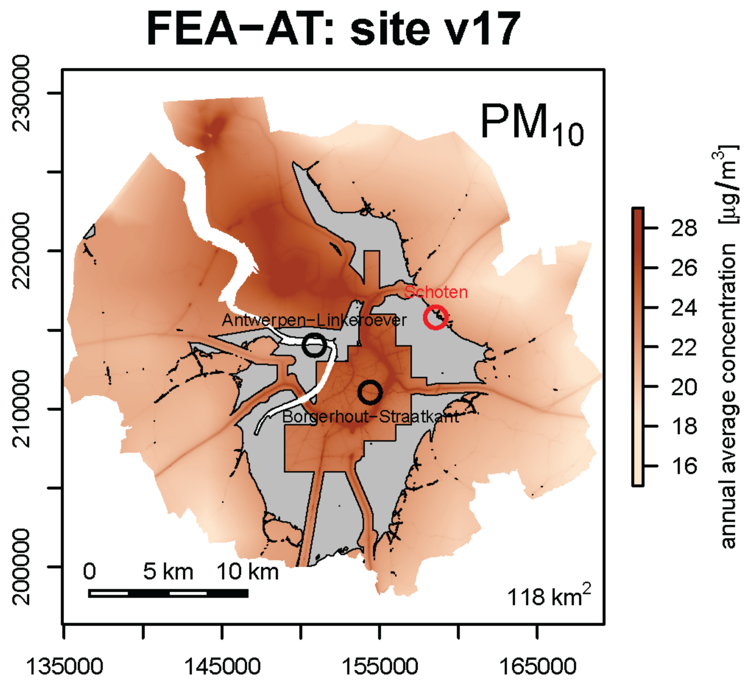
The method applied by **EPAIE** compared 1 year hourly concentration time series of the 341 virtual receptor points to the corresponding time series of the AQMS. Within the SR area the median of the 8784 concentration differences (366 days x 24 hours) should not exceed 20%. For the urban background sites, this assessment was limited to receptor points within 3 km distance around the AQMS. Finally, the SR area was delimitated using kriging interpolation.

SLB: site v17



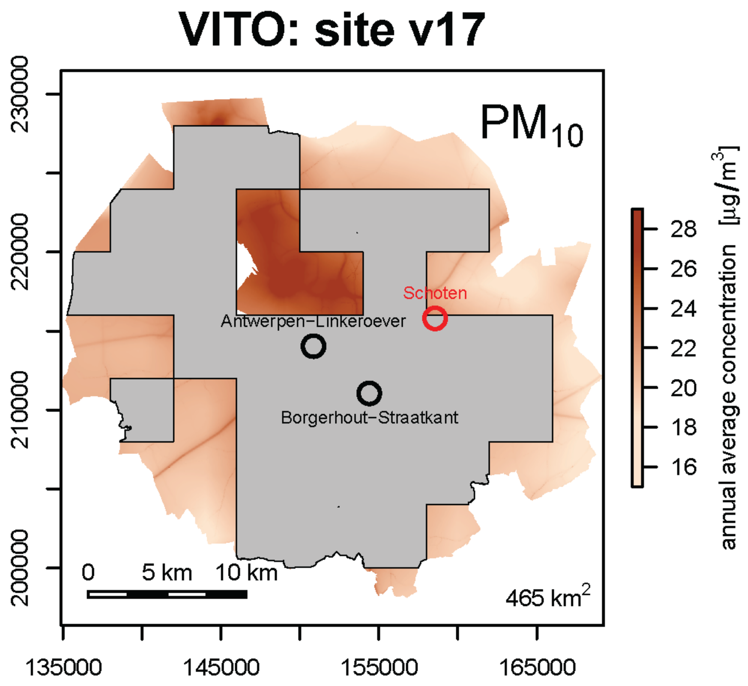
SLB defined the SR area of the urban background sites as a circular zone around the AQMS in which the standard deviation of the modelled annual averages concentration equals to a specific threshold (1.2 µg/m³ for PM_{10}). The standard deviation was calculated on the set of all gridded concentration values within this circular buffer (no privileged role for the values of the station in the centre). The radius was then optimized until the threshold value was reached.

FEA-AT: site v17



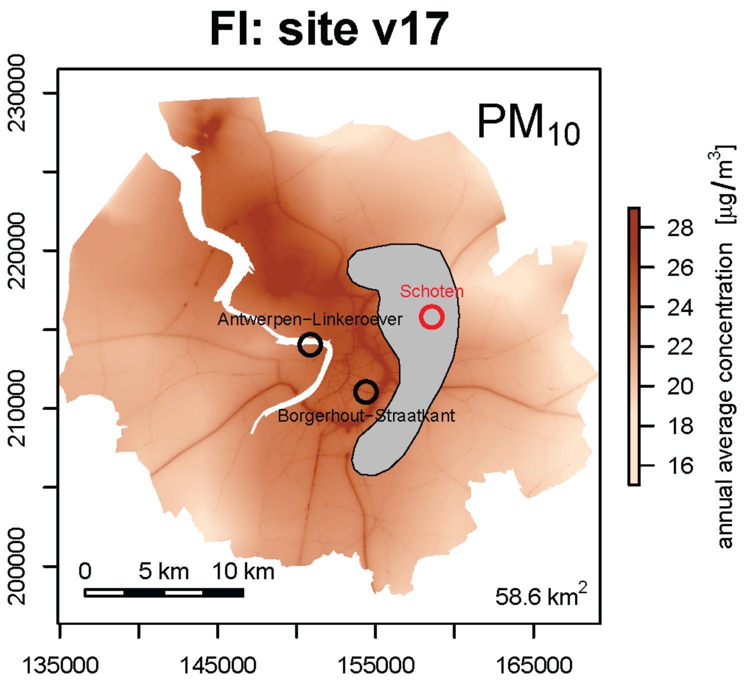
FEA-AT compared the modelled annual mean concentration fields to the AQMS. Similarity thresholds (± 3 µg/m³ for PM_{10}) originate from considerations about the concentration ranges observed in Europe and have been updated for the Antwerp case. In addition, criteria for emissions are applied (for PM_{10}, domestic heating). Industrial areas are separated manually by expert judgement based on the modelled concentration fields.

VITO: site v17



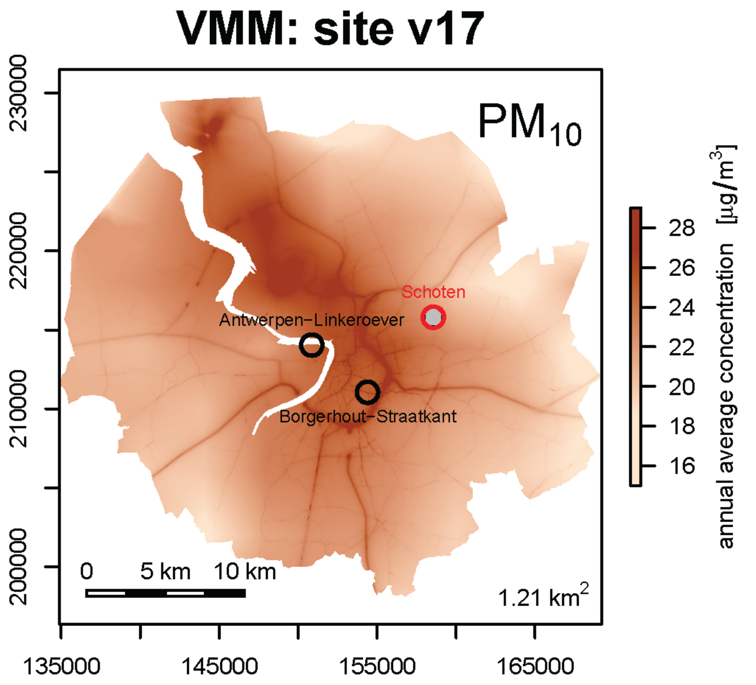
VITO deployed a 'trend function' between pollutant concentrations at all AQMS in the region and a land cover indicator β, optimized to best explain the variations observed in the network. Allowing 15% concentration deviation for a specific AQMS, the trend function is used to assess a corresponding variation in β. The SR area is determined as the set of grid cells for which (i) the β value is within this interval and that (ii) form a contiguous neighbourhood with the AQMS.

FI: site v17



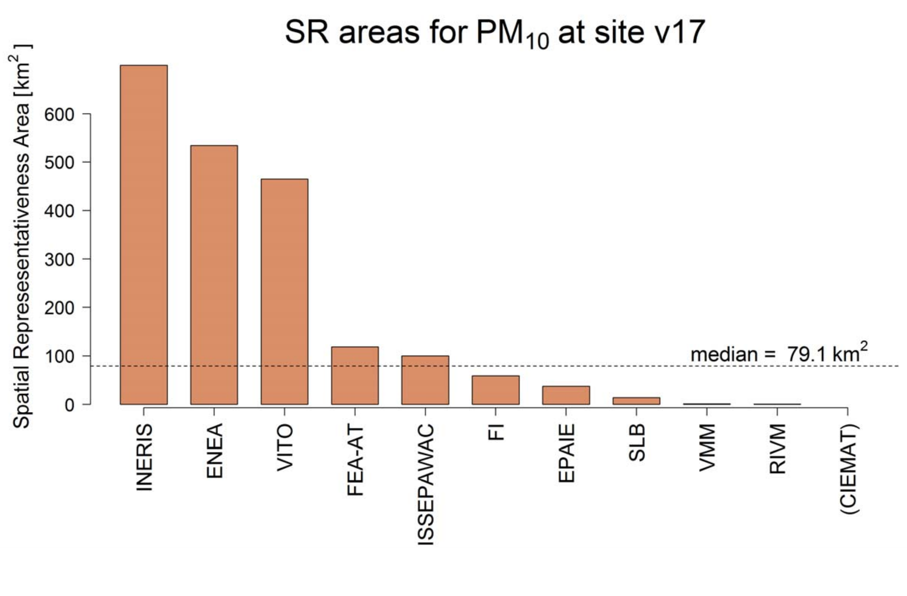
The **Finland** team used annual mean concentrations modelled by VITO, measurements of the AQMS, and data presenting the surrounding (building height & density, roughness, land-use). For the background AQMS, locations of emission sources and wind direction distributions were considered. SR assessment is established on similarity. At background stations this concerns similar city structure and concentrations, and same emission sources.

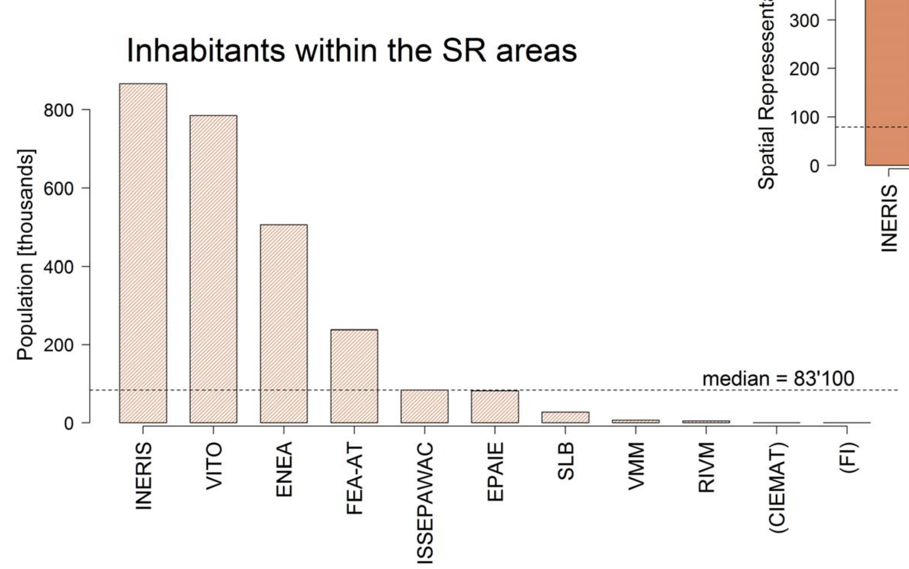
VMM: site v17



VMM applied a classification method considering road traffic, domestic heating (proxy: population density), industrial emissions, and dispersion conditions (proxy: CORINE land cover) for all stations in the network. The surrounding of the AQMS is divided into smaller sub-areas, each of which is classified and compared to the AQMS. Finally the SR area is calculated as the set of sub-areas for which the weighted sum of a similarity indicator is above a given threshold.

Considerable **range of variation** concerning the size of estimated SR areas ...





... as well as regarding the **number of inhabitants** within these SR perimeters.

SUMMARY & CONCLUSIONS

To our best knowledge, this study provides the first attempt to quantitatively compare the range of methods used for estimating the SR of AQMS in Europe. The **considerable variability** of the results obtained by the different teams **concerns the size and position of the SR areas**, but also the **technical procedures** and the extent of **input data effectively used**. Yet the general concept of the area of SR proved to be a useful indicator to work with, important differences revealed regarding the details of the underlying concepts and the SR definitions employed.

The **major factors triggering the diversity of the SR results** are amongst (1) the basic principles of the methods, (2) the parameterizations of similarity criteria and thresholds, (3) the effective use of input data, and (4) the detailed conceptualizations and definitions of SR. The outcomes of the IE underline the **need for** (i) a more **harmonized definition** of the concept of "the area of representativeness" and (ii) **consistent and transparent criteria** used for its quantification.

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