Role of Source Apportionment to support Air Quality management

P. Thunis, E. Pisoni

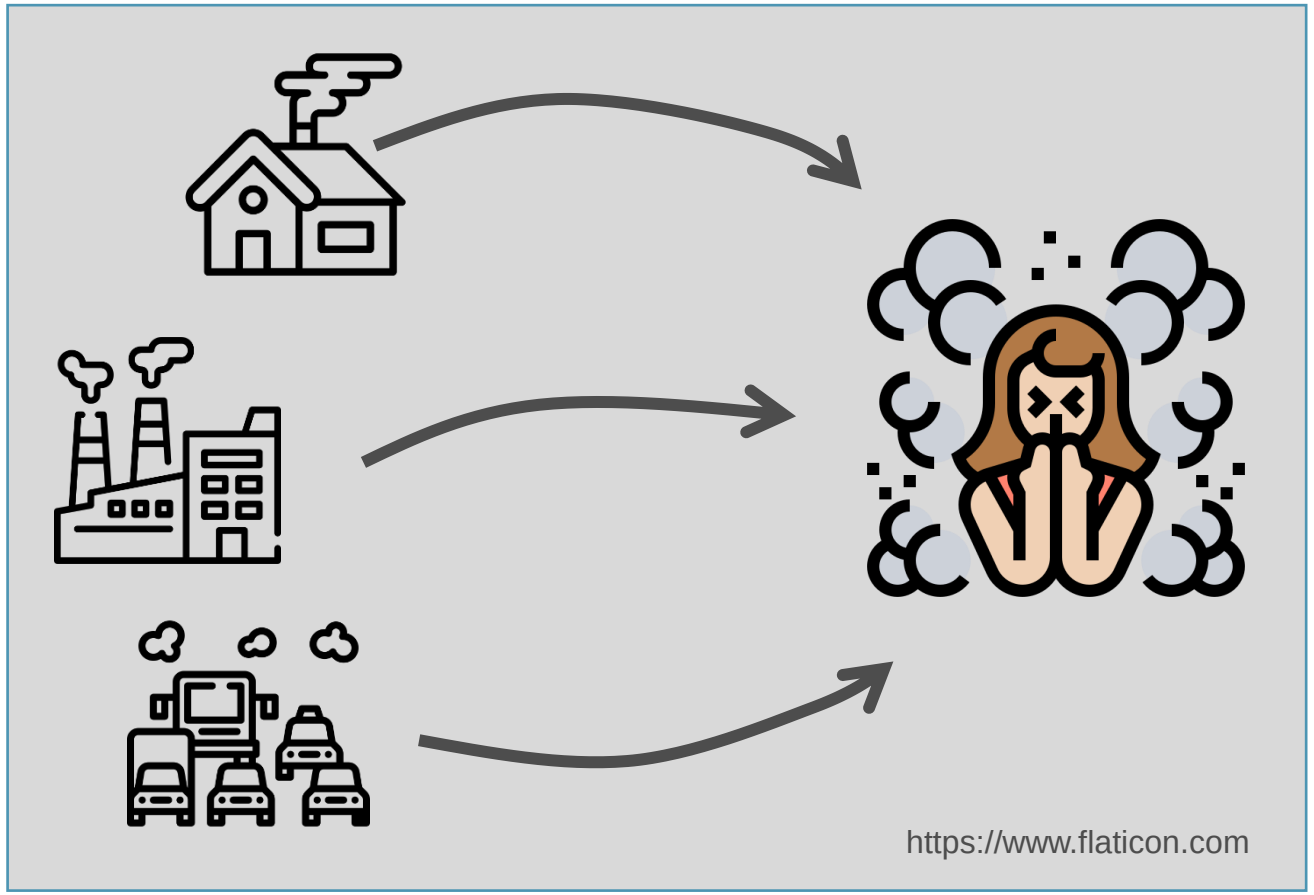
EC-JRC

Concawe Symposium

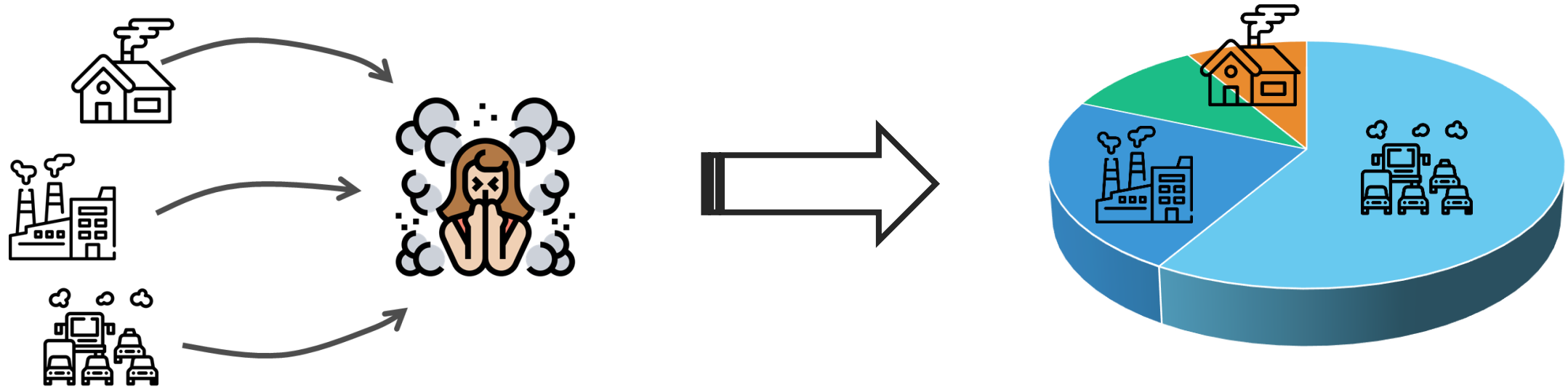
January 2024

Source Apportionment: main concept

Source apportionment is a technique used to **relate emissions from various pollution sources to air pollution concentrations** at a given location and for a given time period.



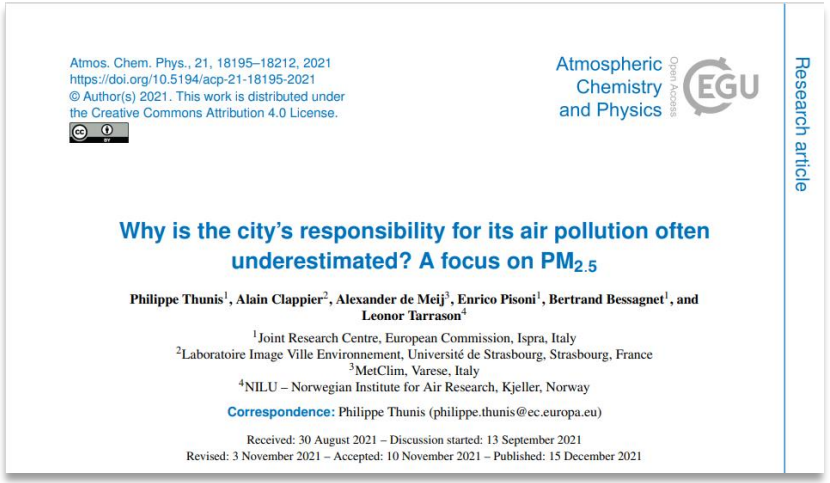
Source Apportionment: what for ?



- Are SA results always easy to obtain and represent?
- Is a simple representation always simple to interpret?
- Source apportionment: yes but for which purpose?

Source apportionment: concepts

How can I relate various pollution sources to concentration at one location?



Atmos. Chem. Phys., 21, 18195–18212, 2021
https://doi.org/10.5194/acp-21-18195-2021

Atmospheric Chemistry and Physics
Research article

Why is the city's responsibility for its air pollution often underestimated? A focus on $PM_{2.5}$

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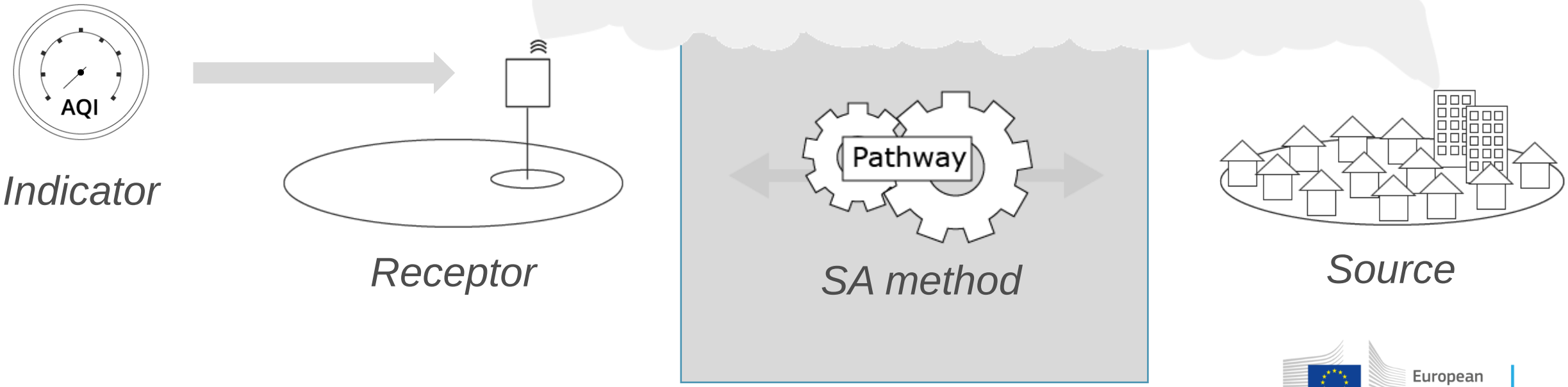
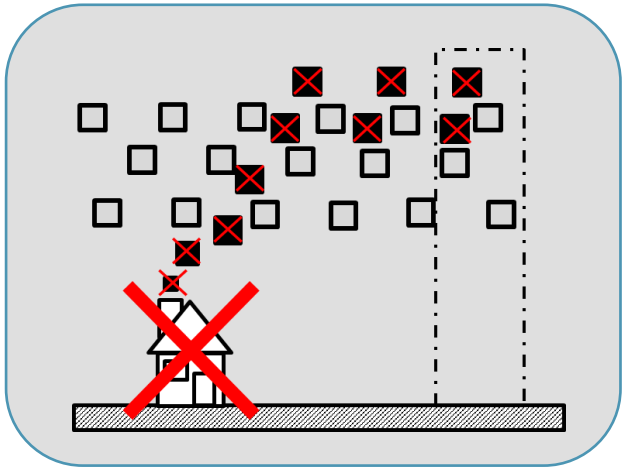


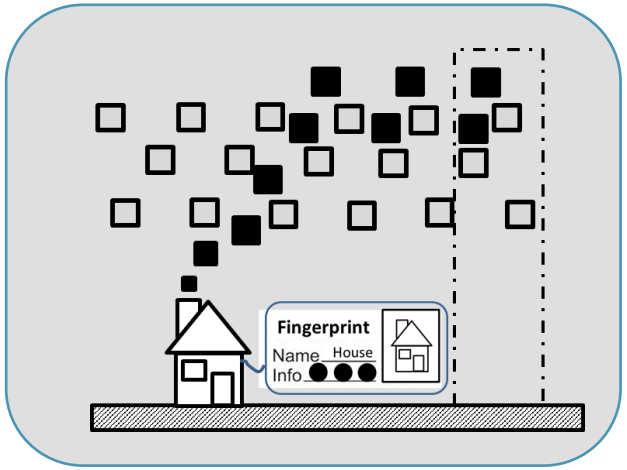
European Commission

Different SA methods exist…

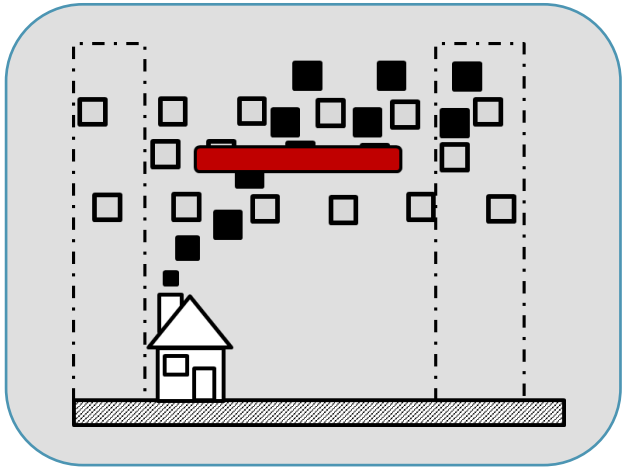


Impacts

GAINS
EMEP (CAMS)
SHERPA
CAMx

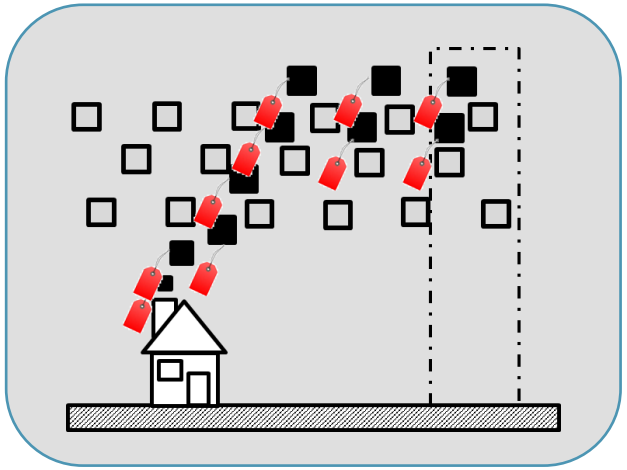


Receptor contributions



Increments

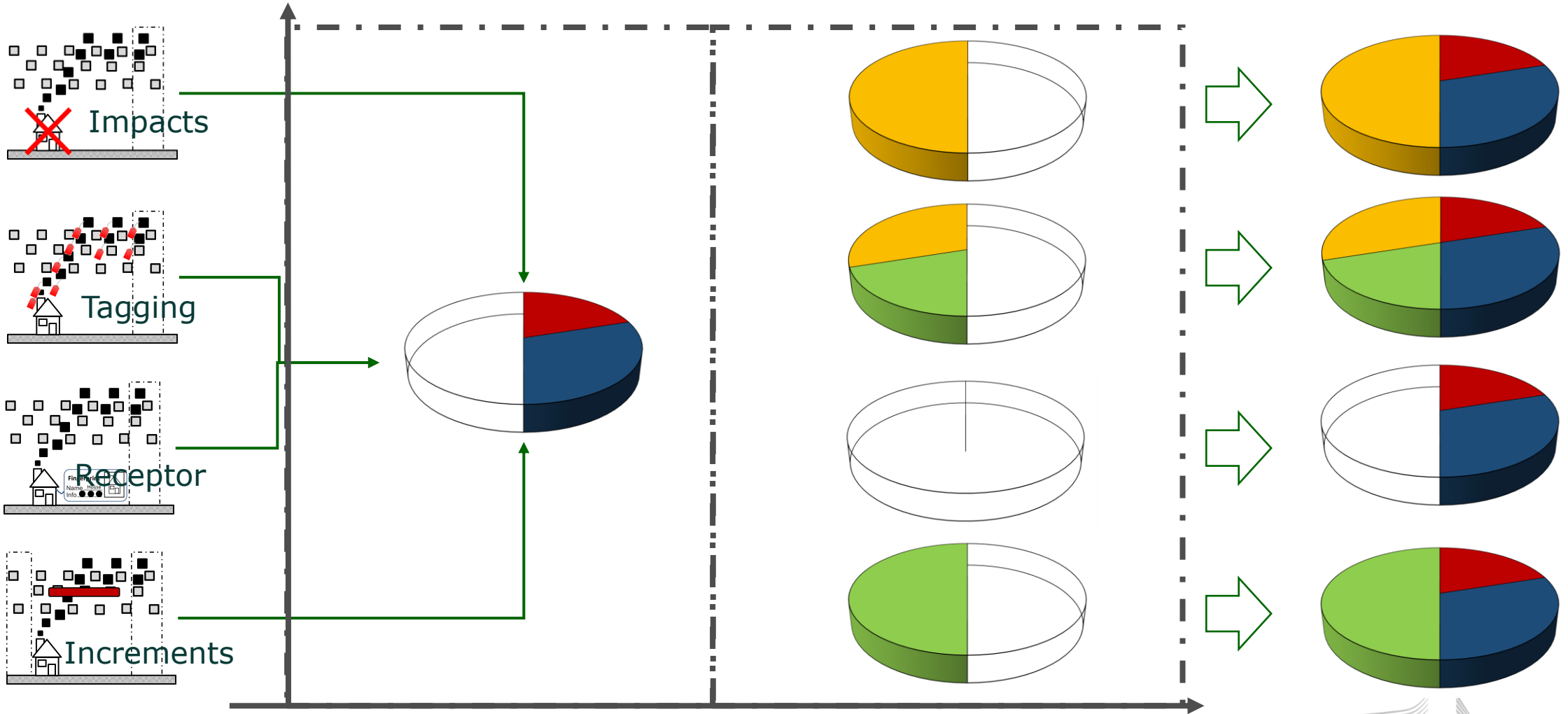
Local AQP



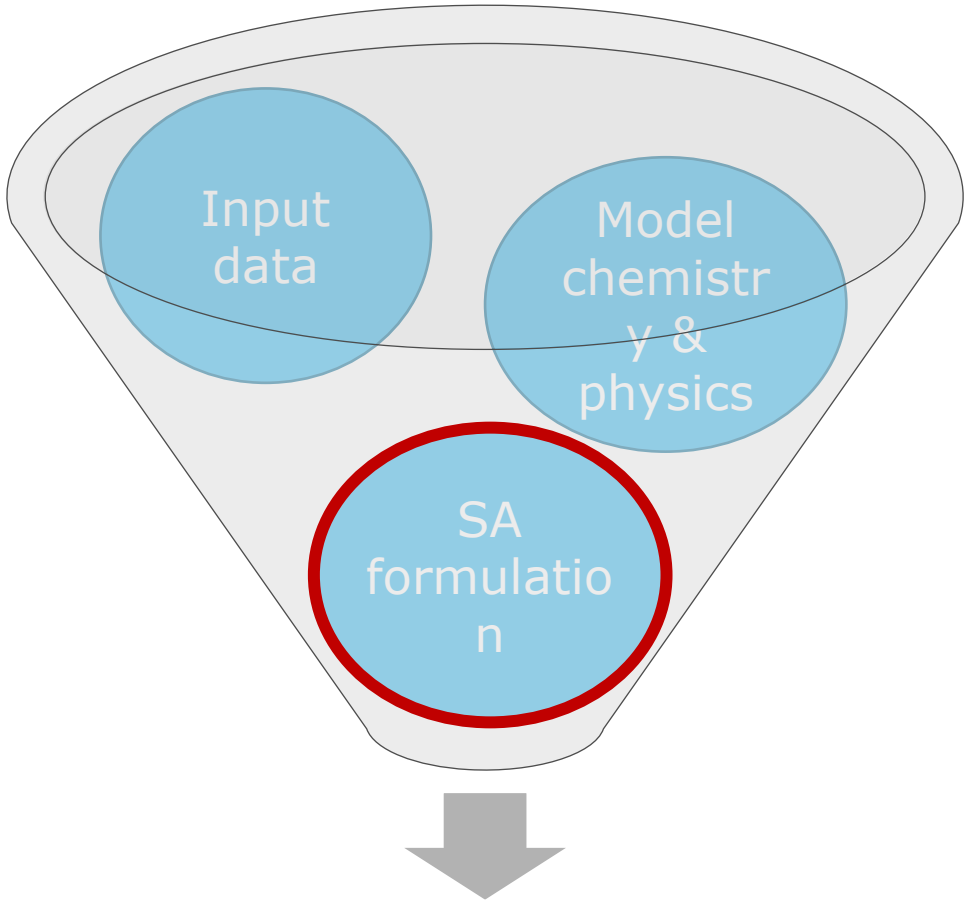
Tagging contributions

LOTOS (TOPAS)
CAMx
CMAQ

SA methods lead to different results for some sources



Differences are mostly conceptual and can be large

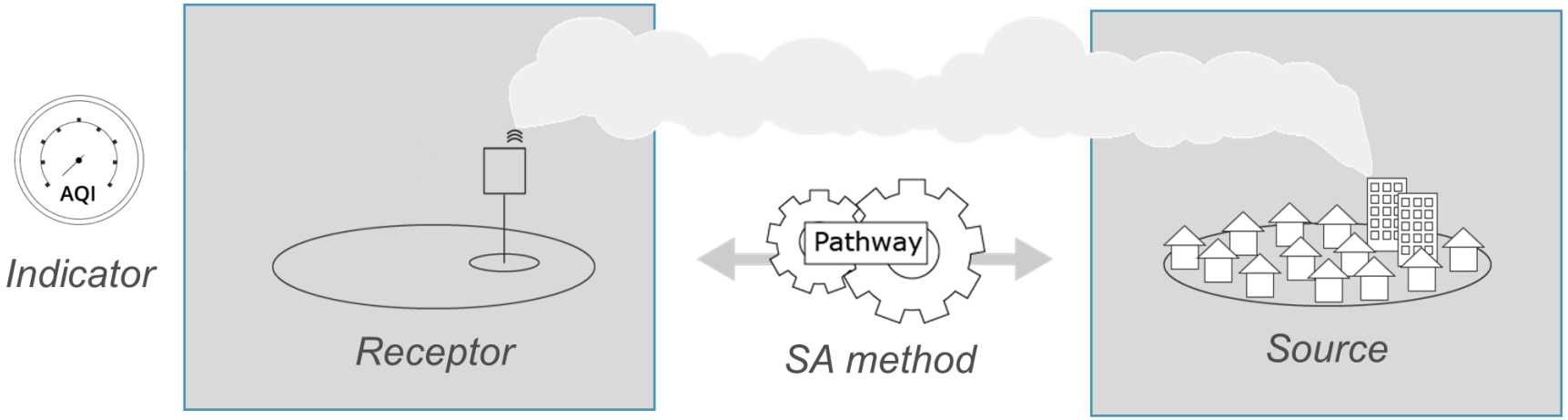


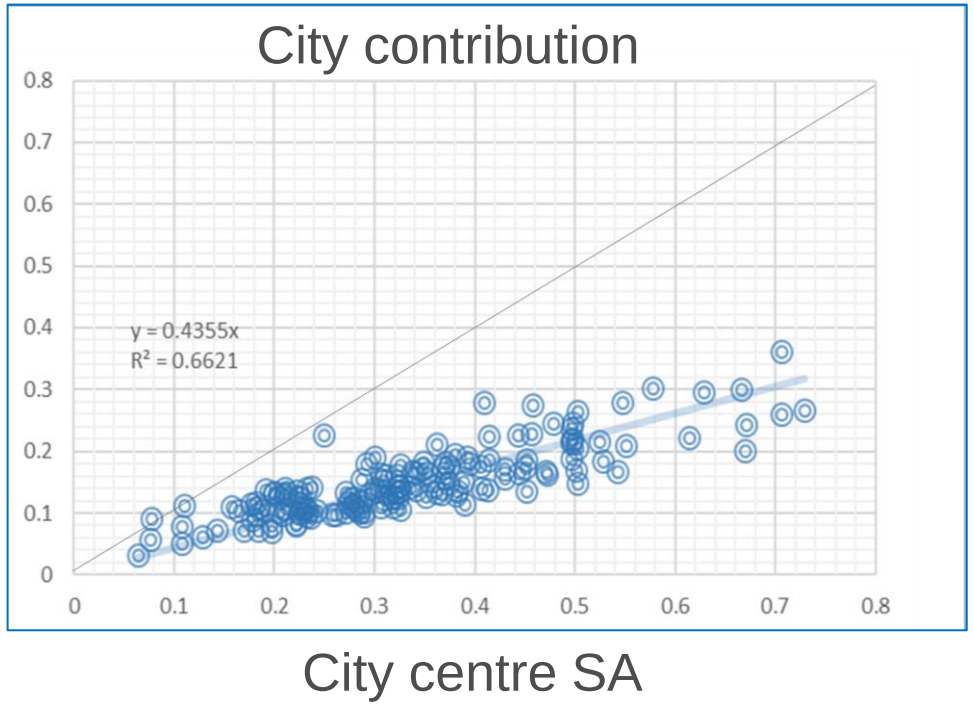
Even if the perfect modeler uses a perfect model with perfect input data, large differences will remain because the SA approaches are **conceptually different**…

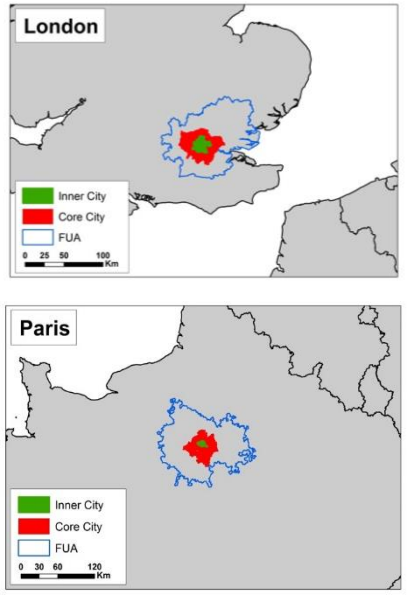
…and are **designed to answer different questions!**

Burr and Zhang (2011), Atmospheric Pollution Research, 2, 318-336
Clappier et al. (2017), Geosci. Model Dev., 10, 4245-4256
Grewe et al. (2010), Geosci. Model Dev., 3, 487–499, 2010
Thunis P. (2018), Atmospheric Environment, 173, 210-222.
Mertens et al. (2018), Atmos. Chem. Phys., 18, 5567–5588
Qiao et al. (2018), Science of the Total Environment 612, 462–471.

Source apportionment: concepts







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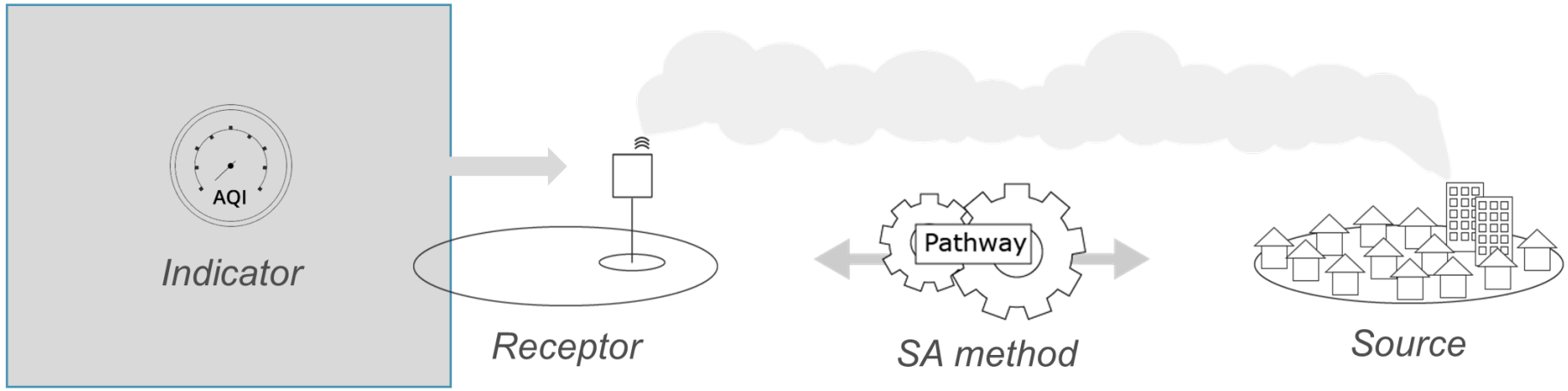
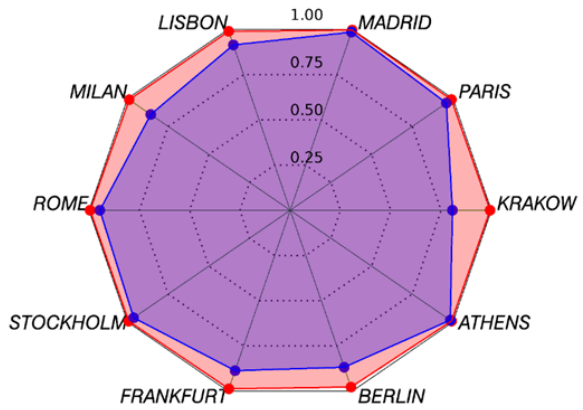
Source apportionment: concepts

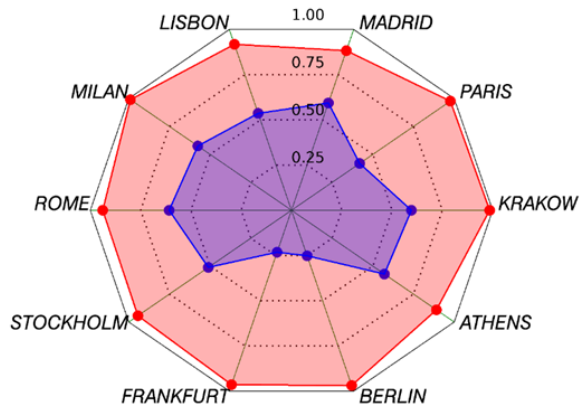


Yearly average NO_2



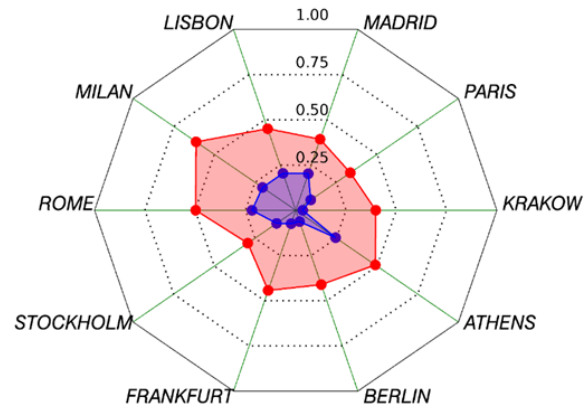
All EU
City only

Yearly average $PM_{2.5}$



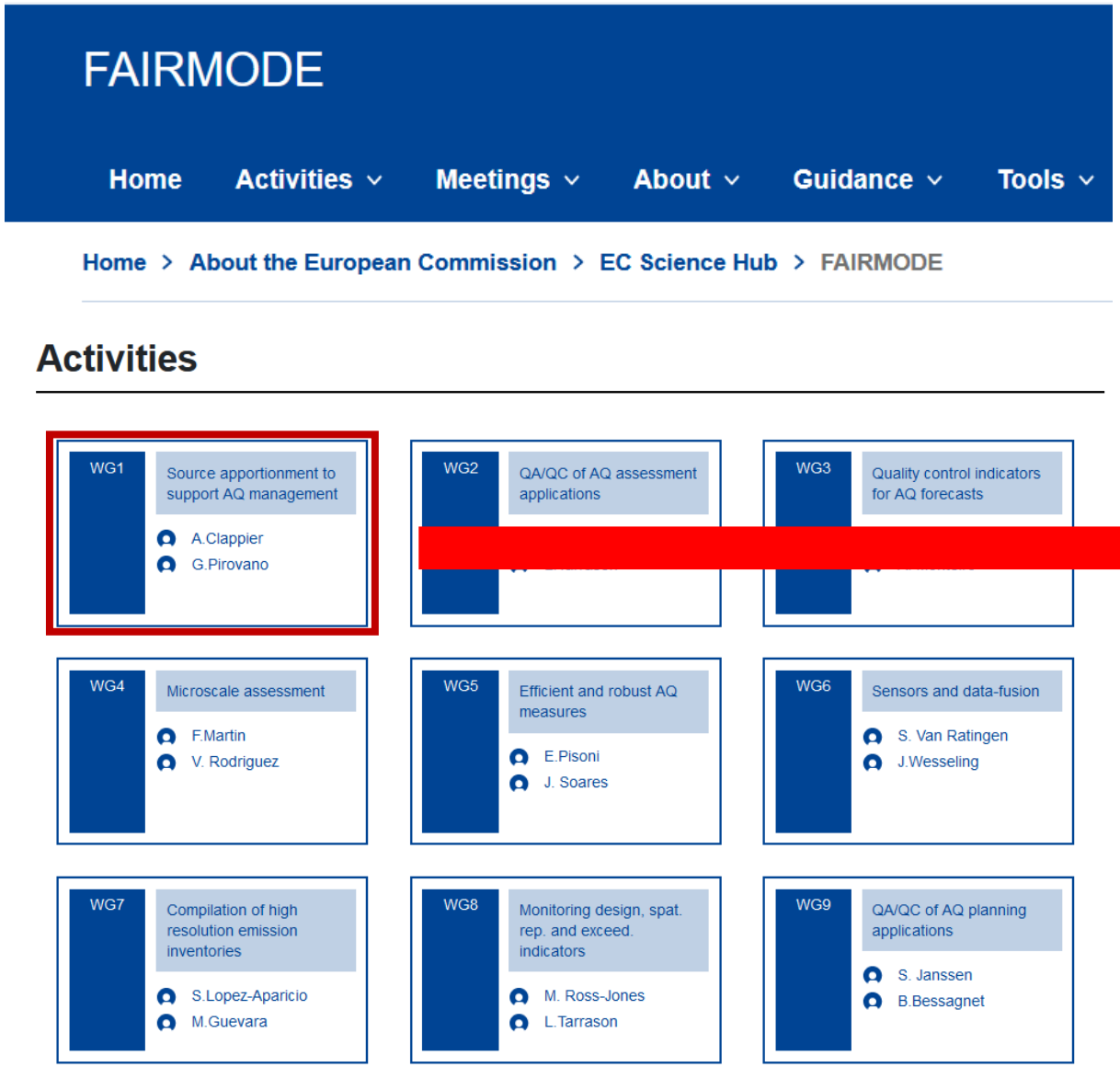
All EU
City only

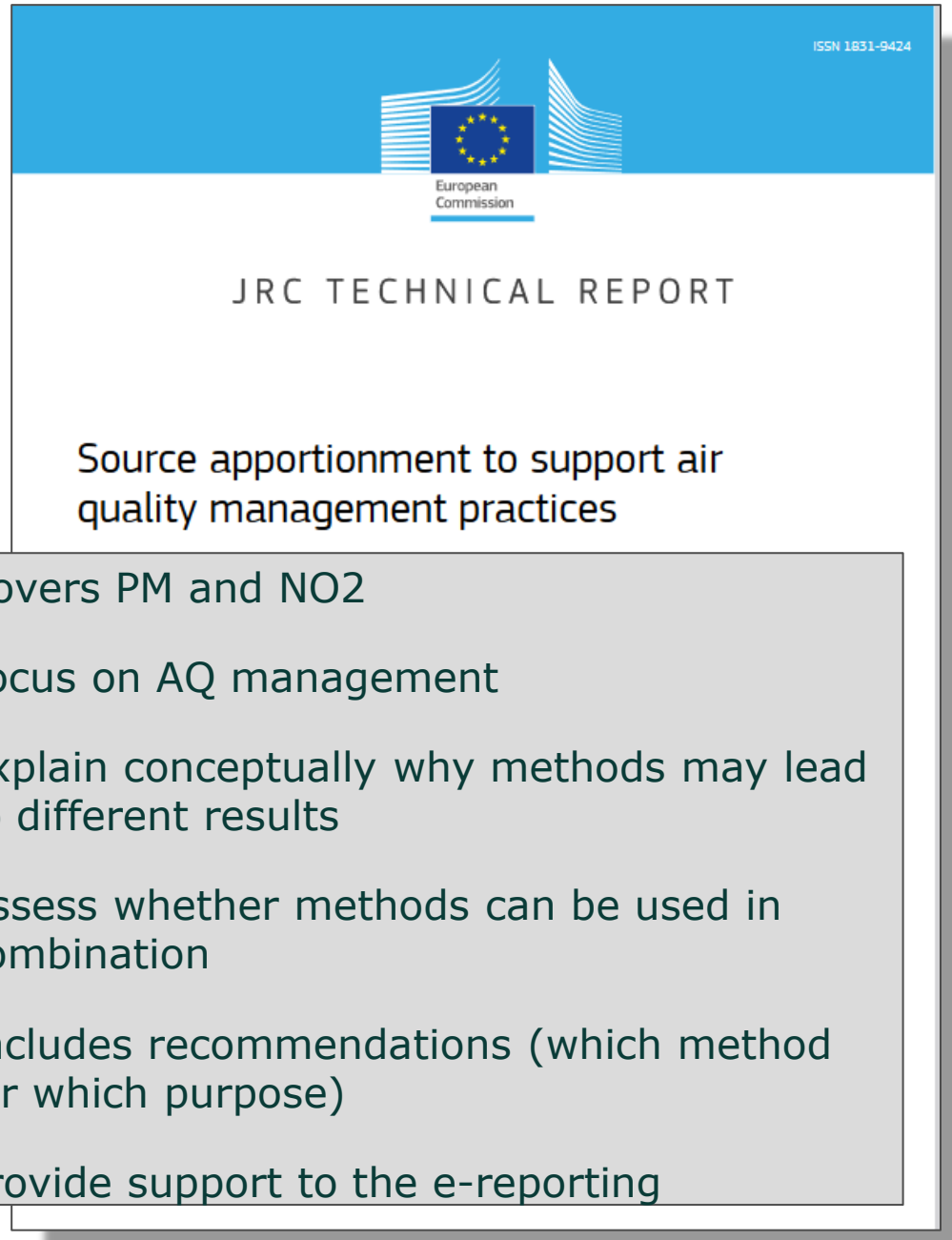
Summer 8h daily max O_3



All EU
City only

https://fairmode.jrc.ec.europa.eu/





I. Covers PM and NO2

II. Focus on AQ management

III. Explain conceptually why methods may lead to different results

IV. Assess whether methods can be used in combination

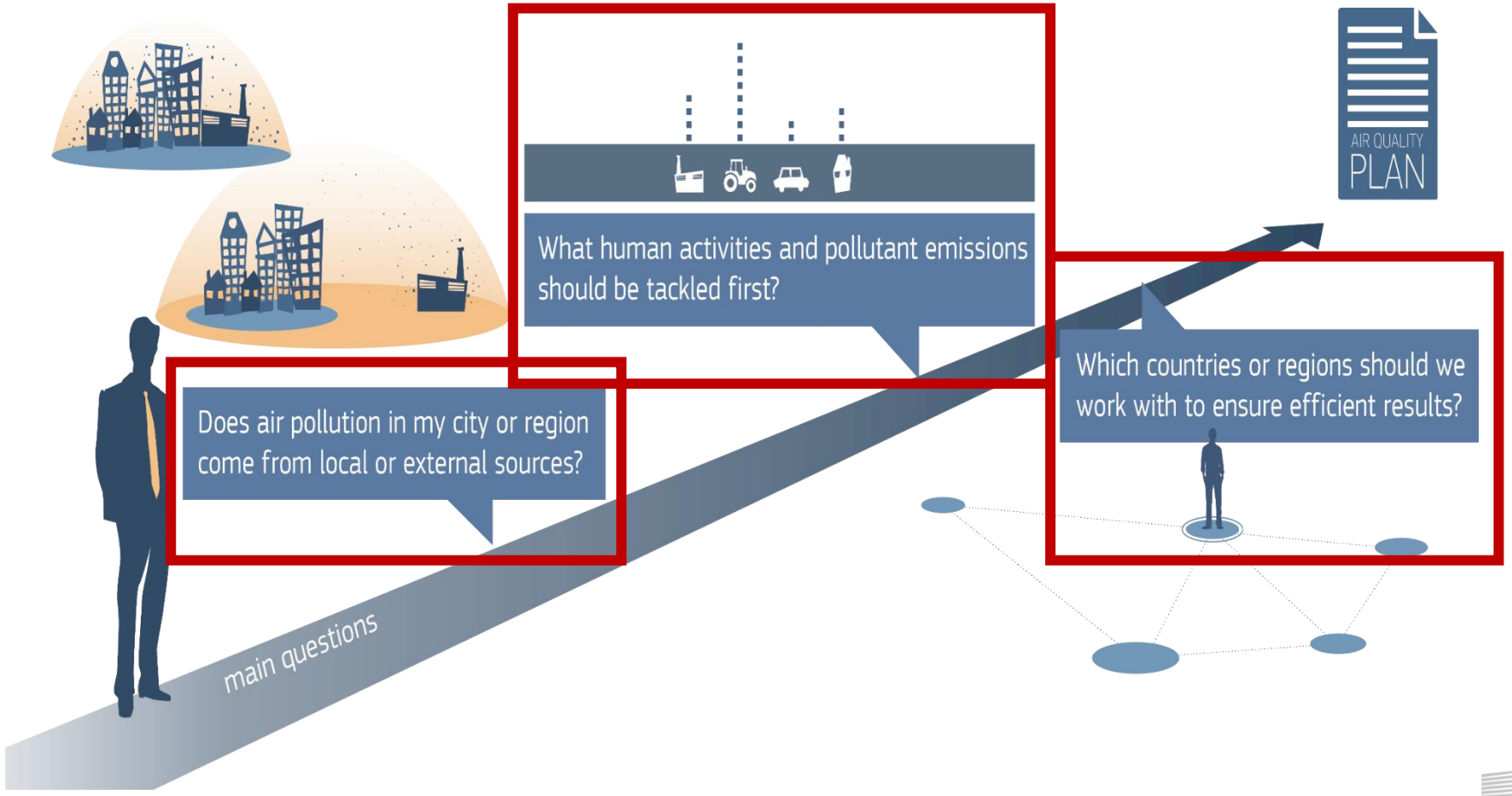
V. Includes recommendations (which method for which purpose)

VI. Provide support to the e-reporting

The SHERPA tool and an example of application

Joint
Research
Centre

A tool to support the design of air quality plans



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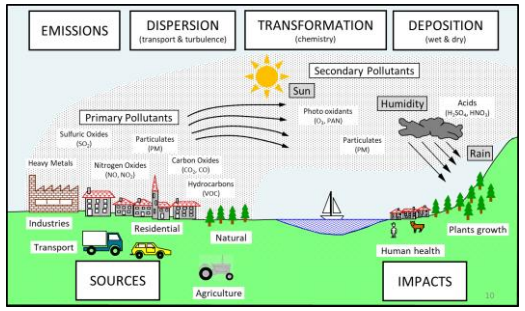
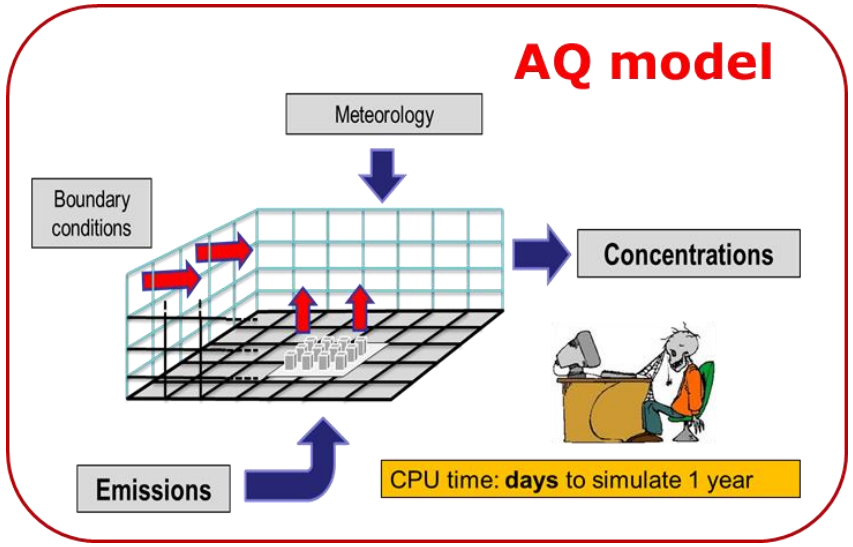
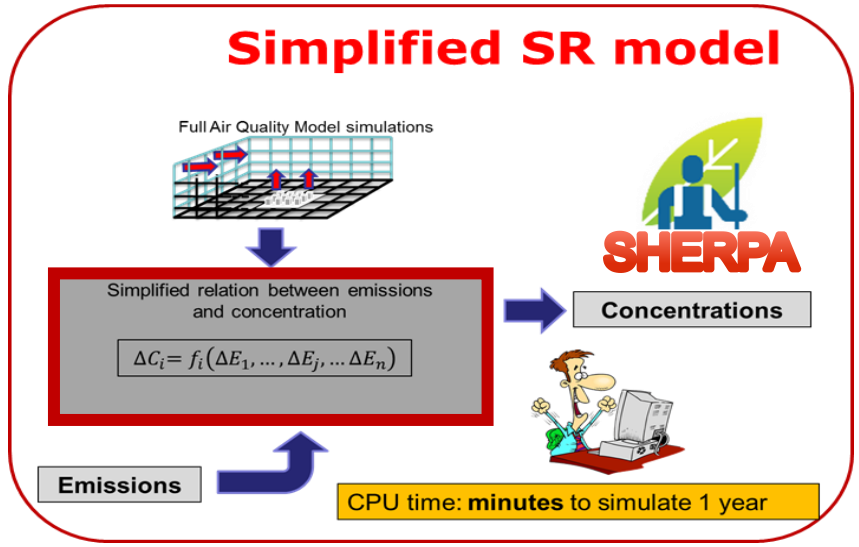
Main challenges and response tools







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journal homepage: www.elsevier.com/locate/jenvman

Research article

On the design and assessment of regional air quality plans: The SHERPA approach

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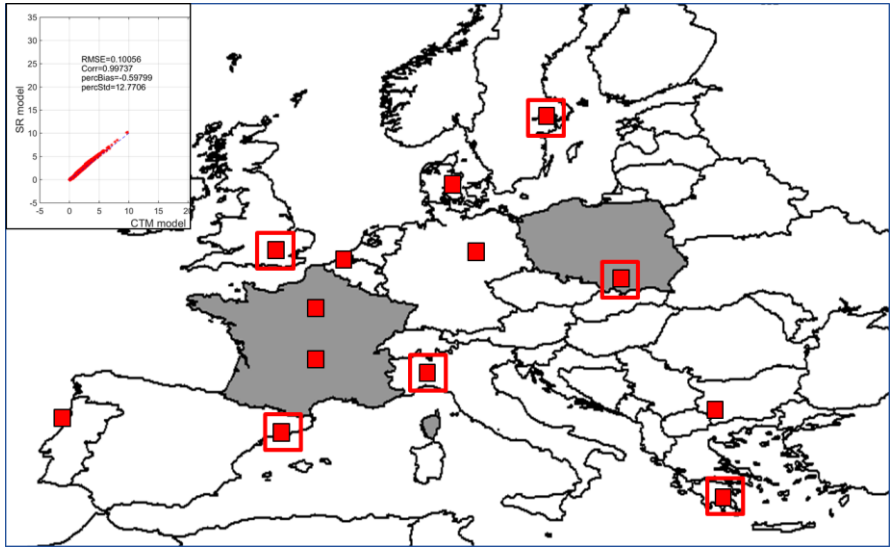
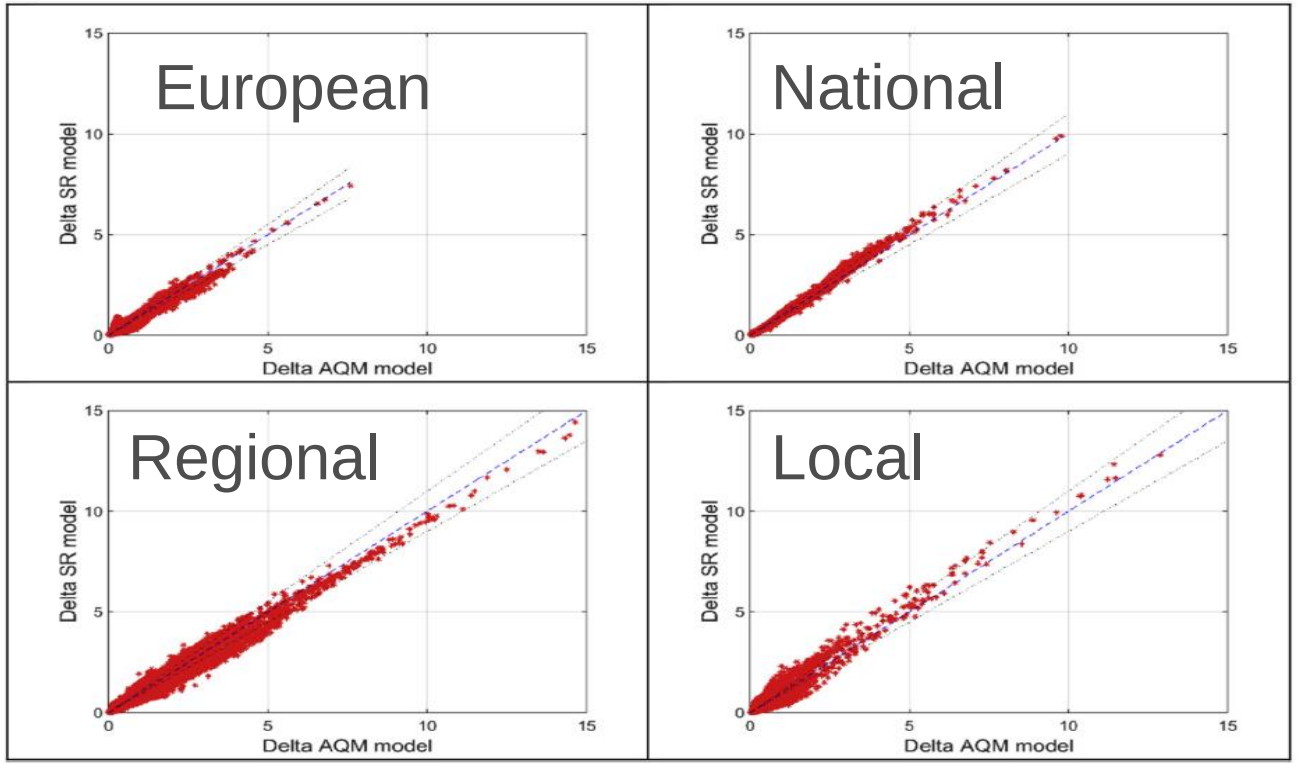
[b] TerrAria srl, Via M. Gioia 132 20125 Milan, Italy
[c] Université de Strasbourg, Laboratoire Image Ville Environnement, Strasbourg, France

SHERPA training & validation





European Commission

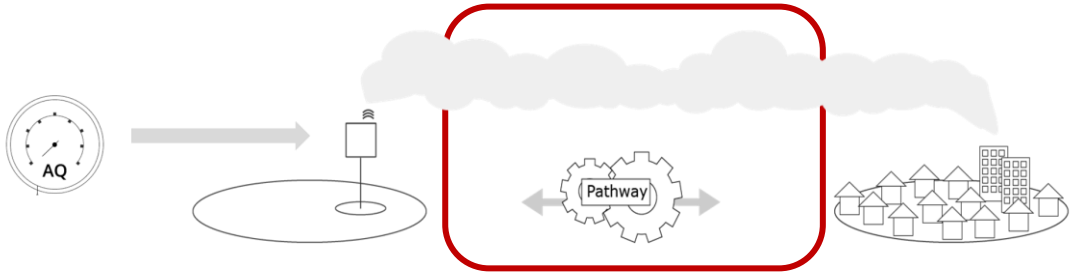
An example of application: The Urban PM2.5 Atlas

https://publications.jrc.ec.europa.eu/repository/handle/JRC134950

Most recent edition: 2023!

European Commission

SA Method



EMEP
0.1x0.05

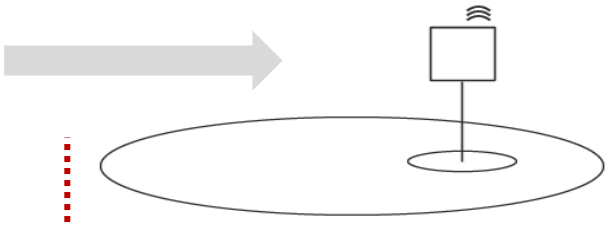
AQ Model

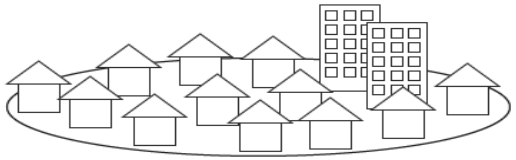
SHERPA

Emissions
CAMS 2019
(with condensables)

Meteo
IFS

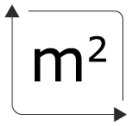
Bound. C.
EMEP





Indicator | *Receptor* | *SA Method* | *Source*

PM2.5

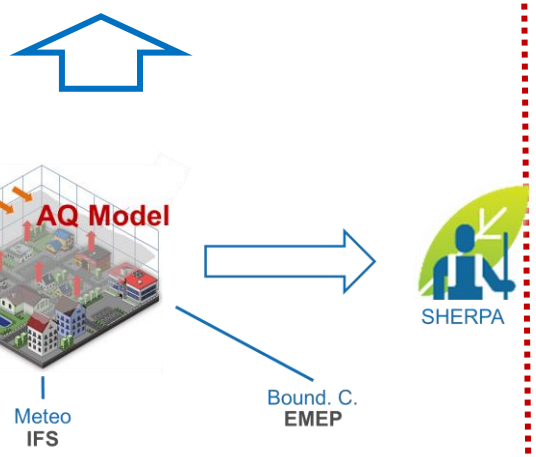


"Hot-spot" model grid cell

Yearly average

Potential impacts (Brute force)

SHERPA



Transport
Residential
Industry
Agriculture
Shipping
Natural
Others

EU30
Country
Comm. Z
City core

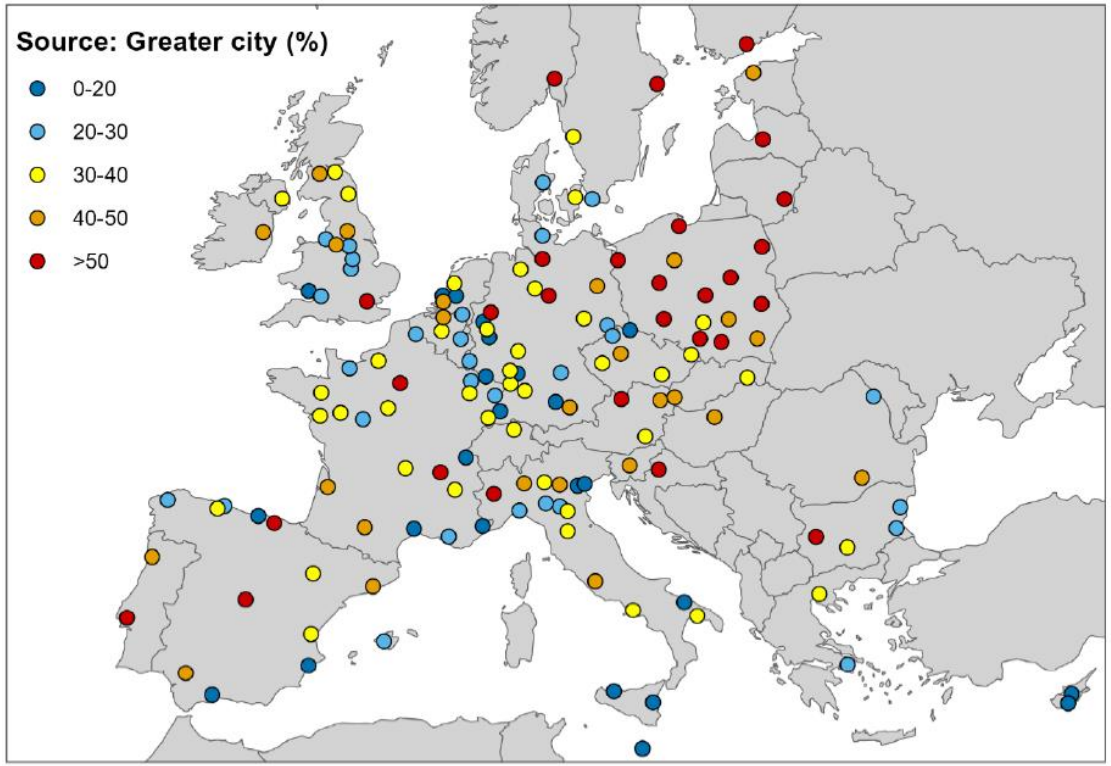
7 sectors X 4 areas

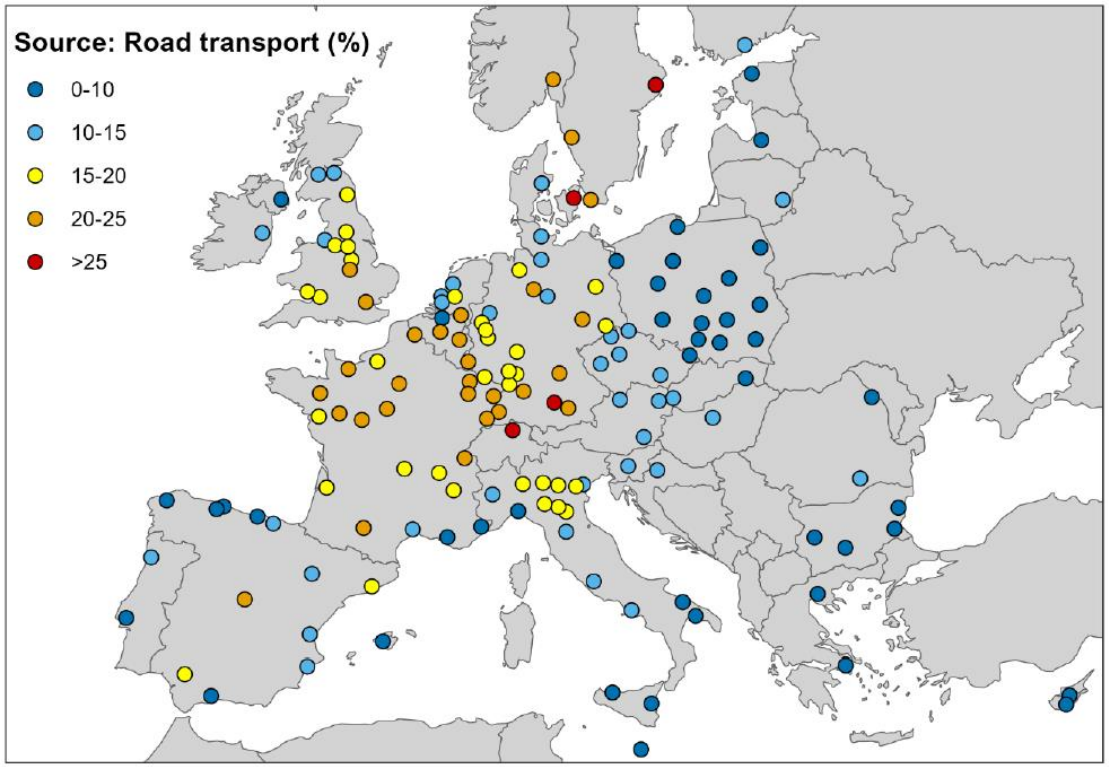
Two main visualisations

1. **All** cities – **One** source (sector or spatial) → Overview maps & rankings

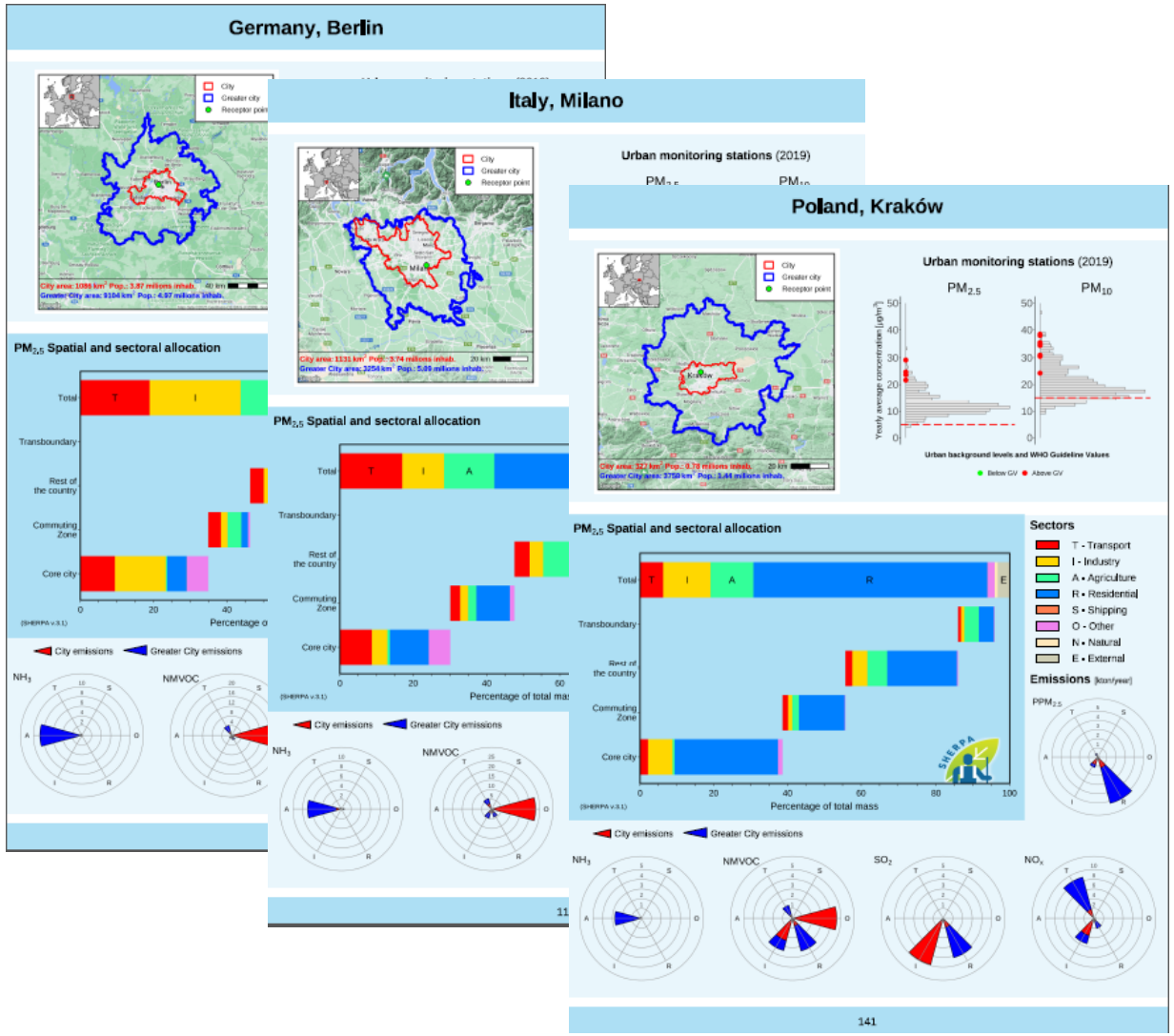
2. **One** city - **All** sources (sectors and spatial) → City Fiches

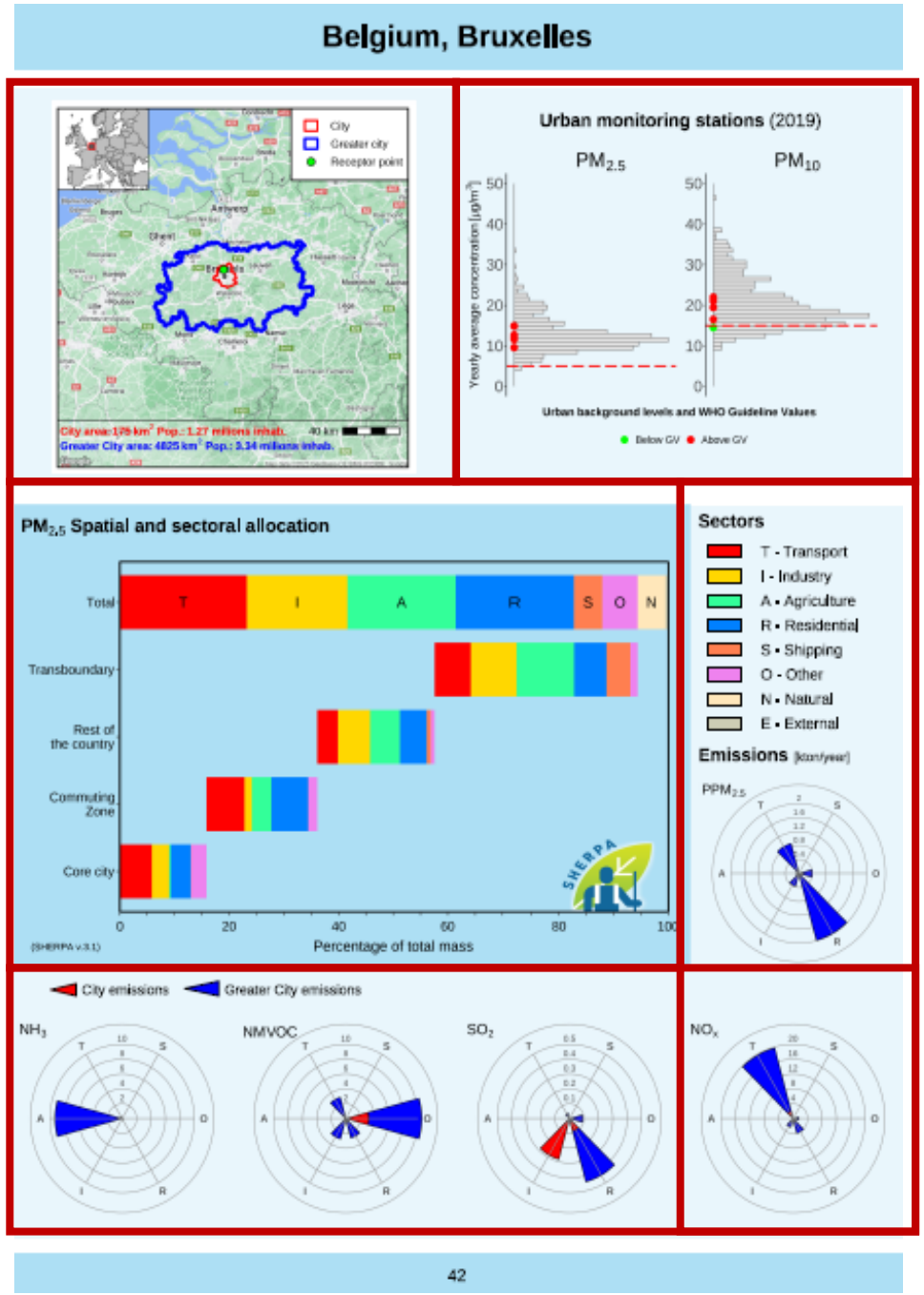
Overview maps





City fiches


Germany, Berlin
Italy, Milano
Urban monitoring stations (2019)
Poland, Kraków
Urban monitoring stations (2019)
PM2.5 Spatial and sectoral allocation
PM2.5 Spatial and sectoral allocation
PM2.5 Spatial and sectoral allocation
Sectors
T - Transport
I - Industry
A - Agriculture
R - Residential
S - Shipping
O - Other
N - Natural
E - External
Emissions
City emissions
Greater City emissions
NH3
NMVOC
SO2
NOx
Percentage of total mass
141


Belgium, Bruxelles
Urban monitoring stations (2019)
PM2.5
PM10
Urban background levels and WHO Guideline Values
PM2.5 Spatial and sectoral allocation
Sectors
T - Transport
I - Industry
A - Agriculture
R - Residential
S - Shipping
O - Other
N - Natural
E - External
Emissions
Percentage of total mass
City emissions
Greater City emissions
NH3
NMVOC
SO2
NOx
42

Conclusions from the Atlas

- For many cities, local actions at the urban scale are an effective mean of reducing PM2.5 concentrations in that city
- Target sectors and scales to abate air pollution are city specific.
- Sectoral measures addressing residential heating at the local level would be very effective.
- Sectoral measures addressing agriculture at country- or EU- scale have a clear benefit on urban air quality.
- The complete fulfilment of ammonia national emission reduction commitments under the NEC Directive will bring tangible benefits to air quality in a large number of European cities.

SHERPA model and Atlas results

The model and Atlas results (for 750 cities) are available at

https://jeodpp.jrc.ec.europa.eu/eu/dashboard/voila/render/SHERPA/Sherpa.ipynb

Thank-you

European Commission