

Intercomparison Exercise of Spatial Representativeness Methods

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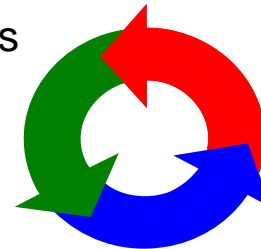
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SLB-analys - our organisation

- Unit at Stockholm Health and Environment Administration
- Operator of Eastern Sweden's Air Quality Management Association (4 counties with 50 municipalities, ~ 1/3 of total population in Sweden)

Air quality management system

Urban dispersion models
(Gaussian, street-canyon,
CFD)



Bottom-up emission
databases

Monitoring stations
(air pollutants and
meteorological
parameters)



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Strategies for our measurements

- Regional background stations
 - Import of air pollutants into the region from emissions from the rest of Sweden and Europe
- Urban background stations
 - Represents air quality in the region in general and the average exposure of air pollutants
- Traffic stations
 - Represents the areas with the highest concentrations of air pollutants
 - Control of air quality standards



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Motivation for participate in this exercise

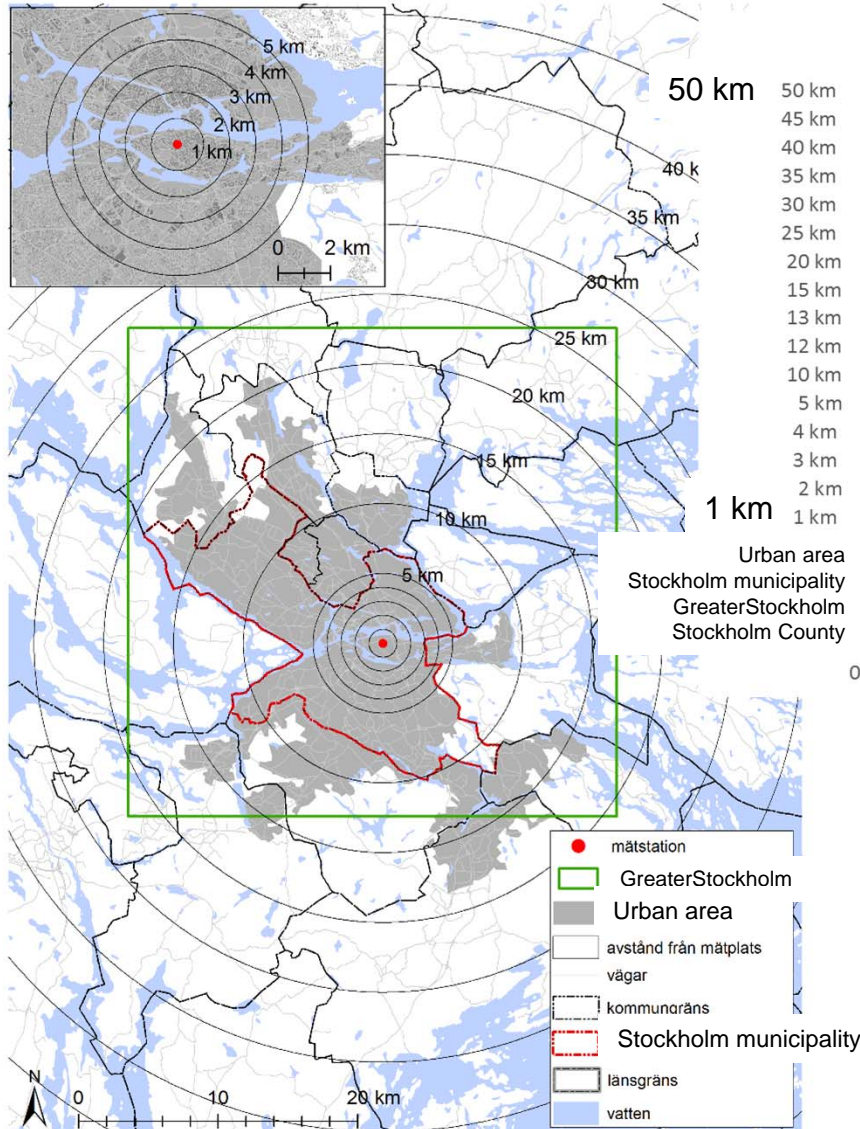
- We have a great interest in this topic
 - In Sweden, it has for exemple been discussed a lot in the context of how many background stations a city or a region must have.
- We have a relatively simple and unsophisticated method for determination of area of spatial representiveness.
 - We decided to join the exercise anyway because by participating we get more involvement and more understanding of the work of the other groups.



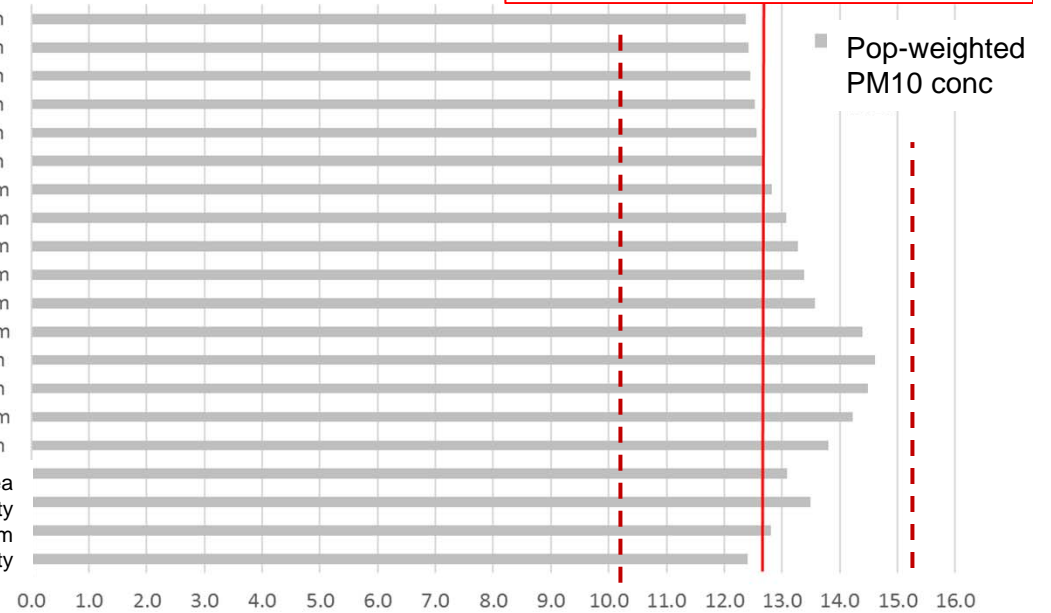
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Method: urban background stations, PM10

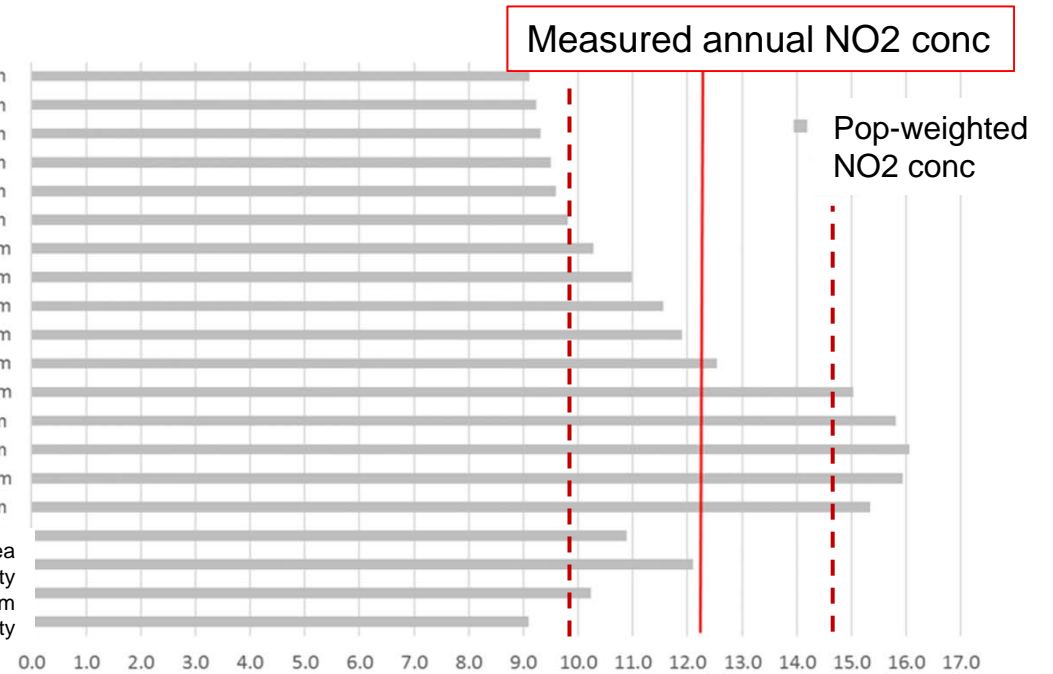
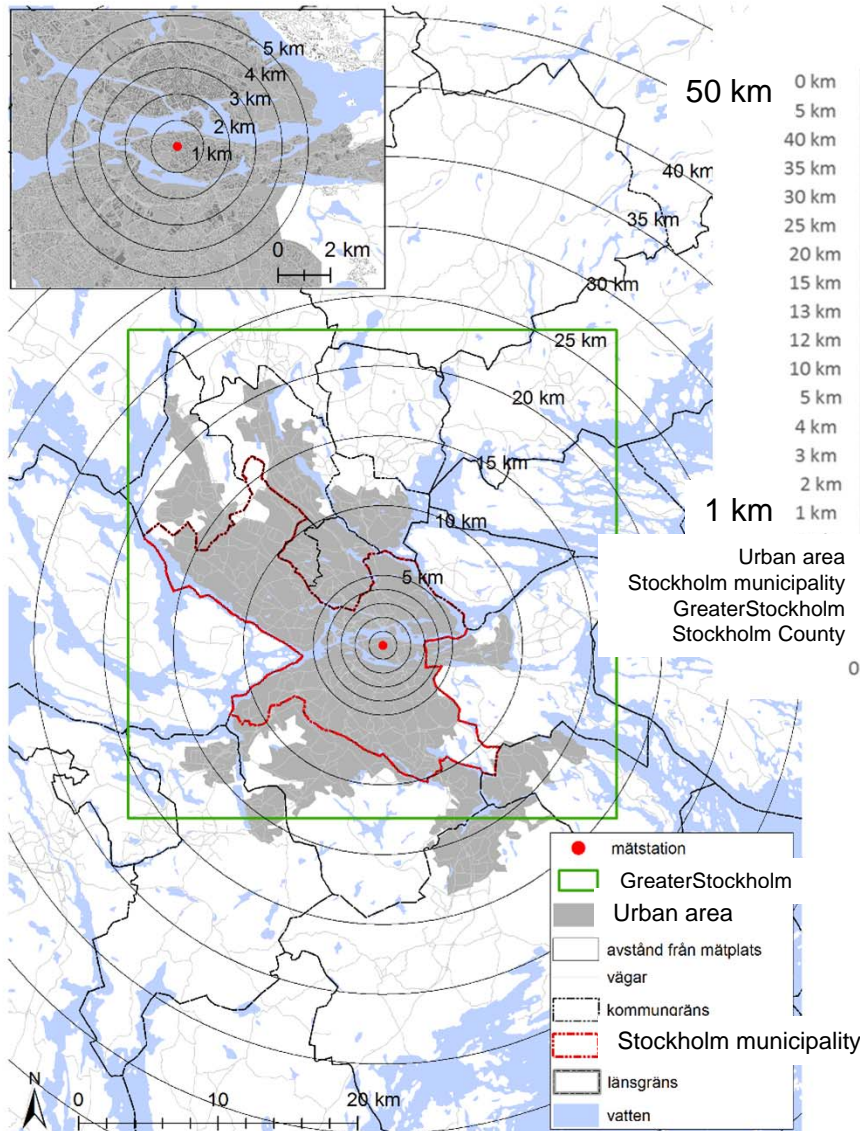


Measured annual PM10 conc



±20%
PM10 conc

Method: urban background stations, NO2

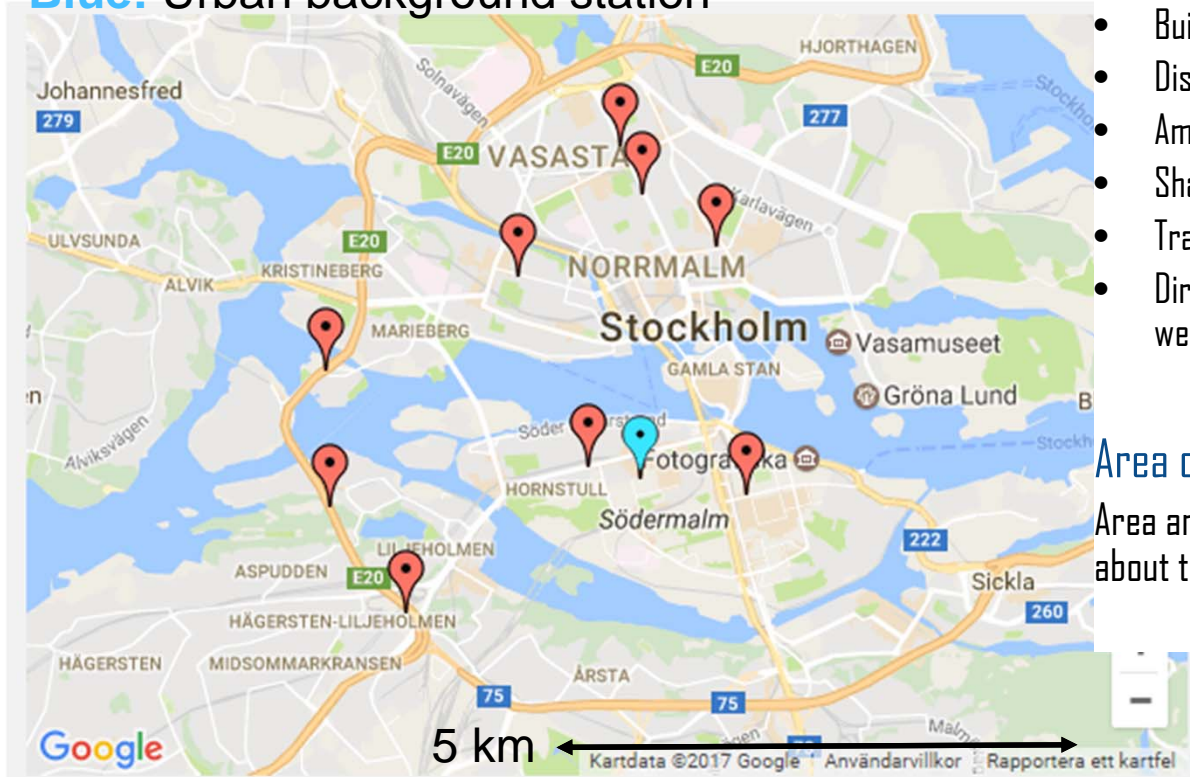


Method traffic sites

Monitoring stations

Red: Traffic stations

Blue: Urban background station



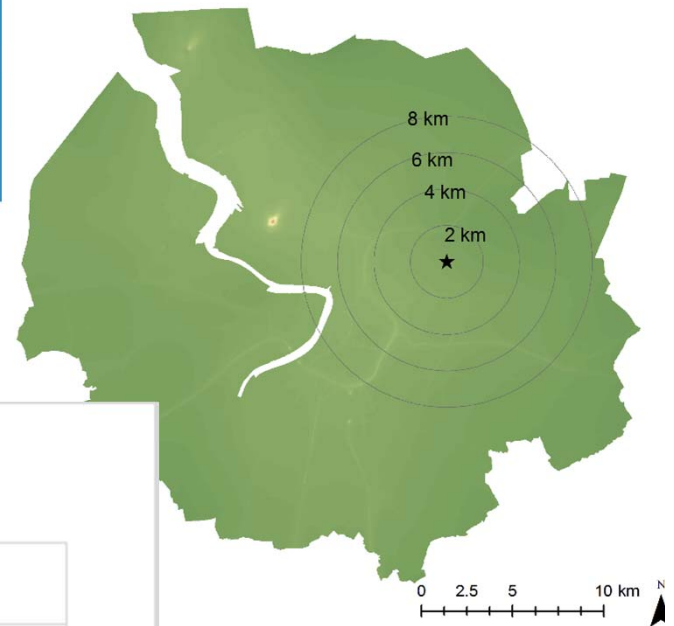
Difficult to apply measurements from one traffic monitoring site to an adjacent street canyon

- Buildings on one or both sides
- Distance between houses
- Amount of traffic
- Share of heavy-duty traffic
- Traffic rhythm
- Direction of the street, e.g. north-south or west-east

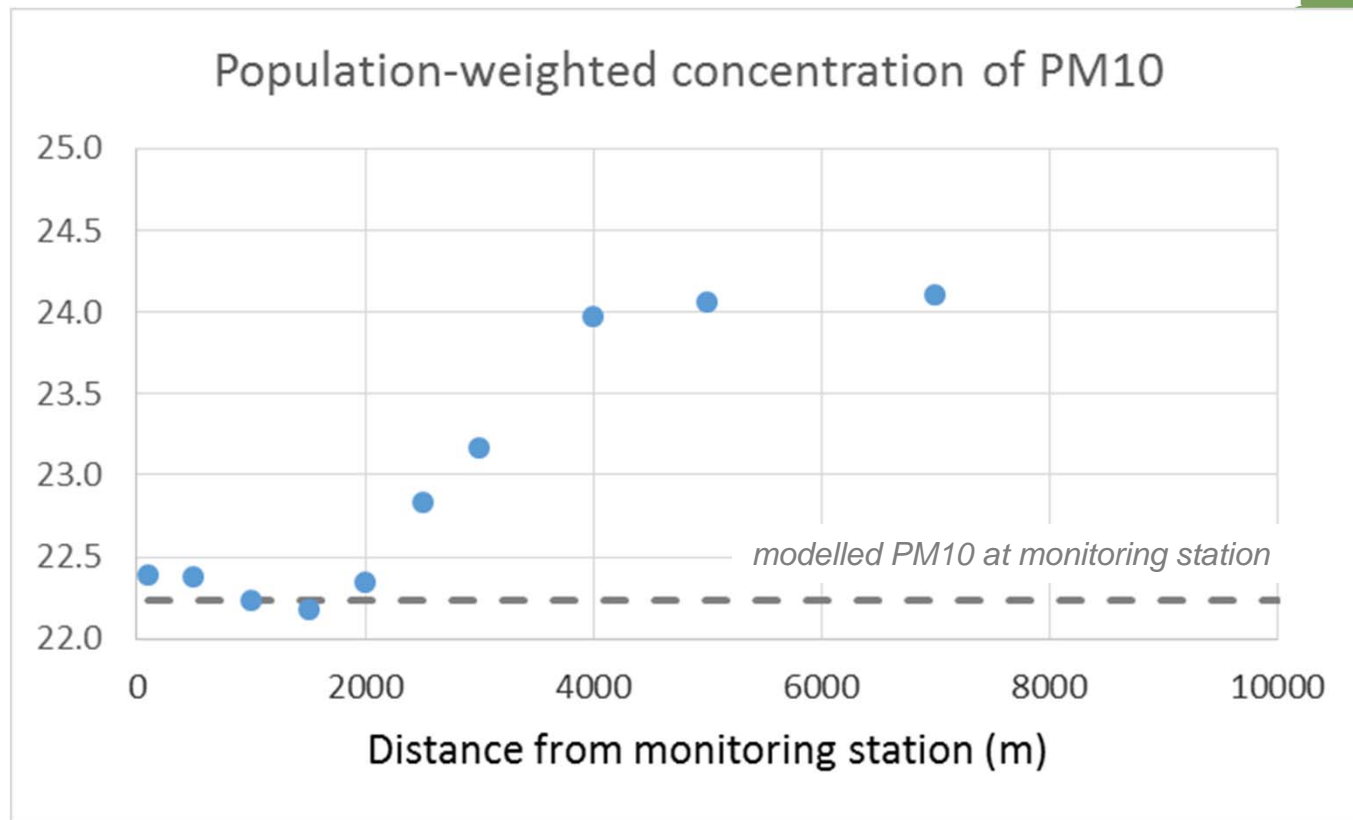
Area of representativeness =

Area around the station where all above parameters are about the same

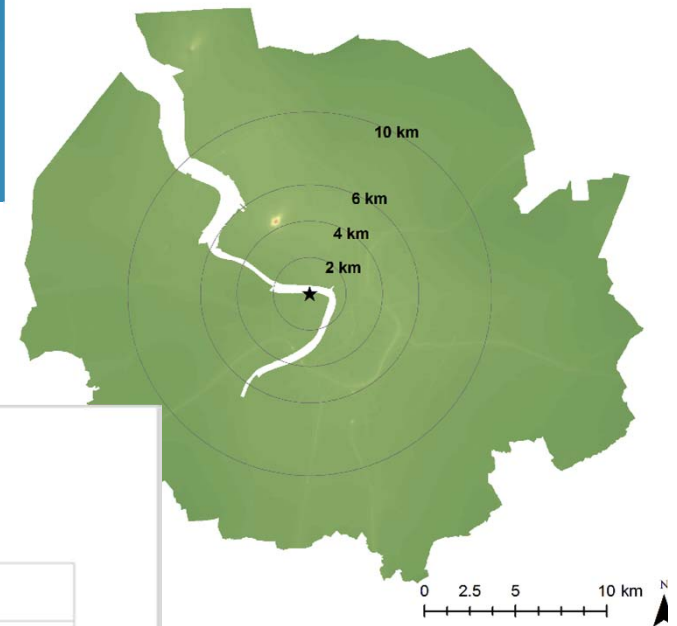
Zonal analysis Schoten



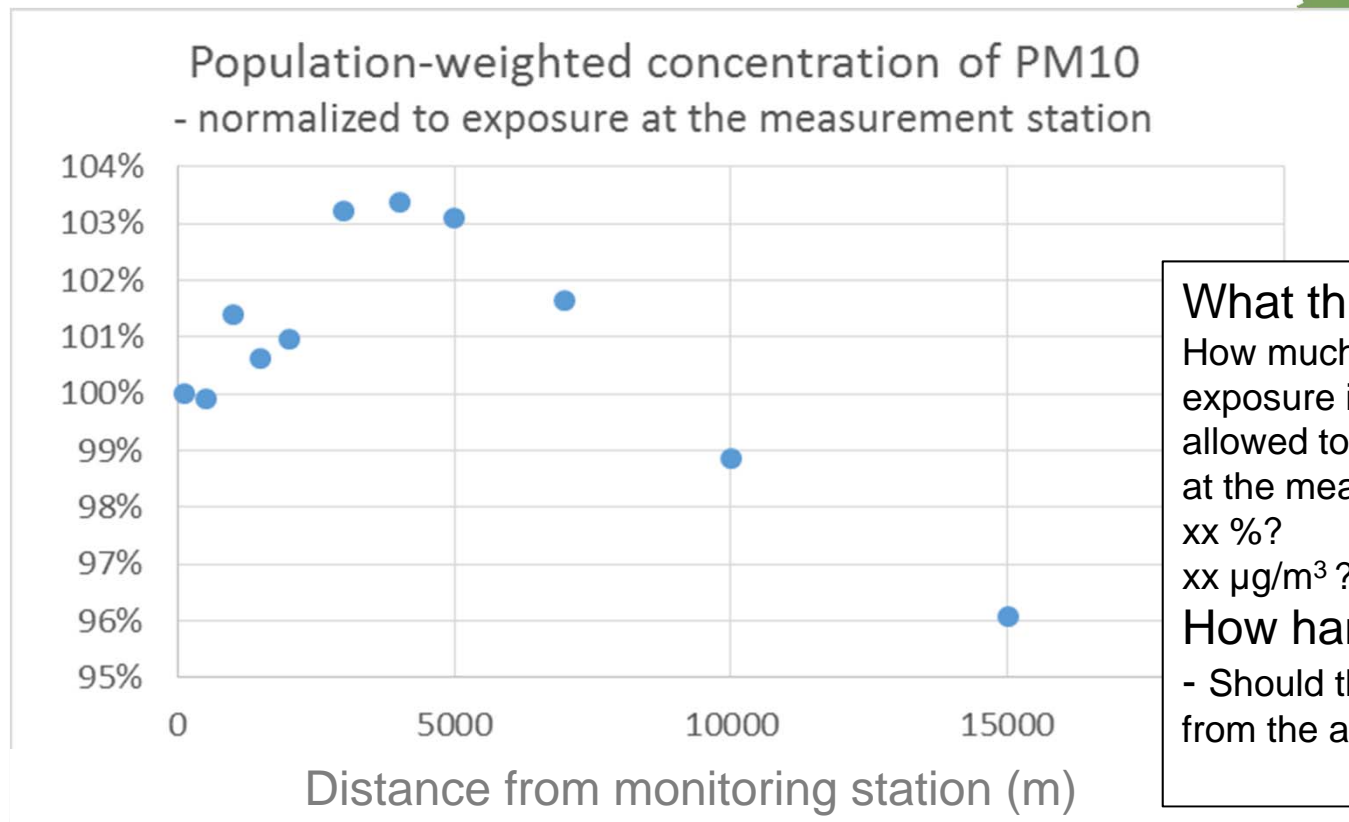
PM10



Zonal analysis Antwerpen LinkerOever



PM10

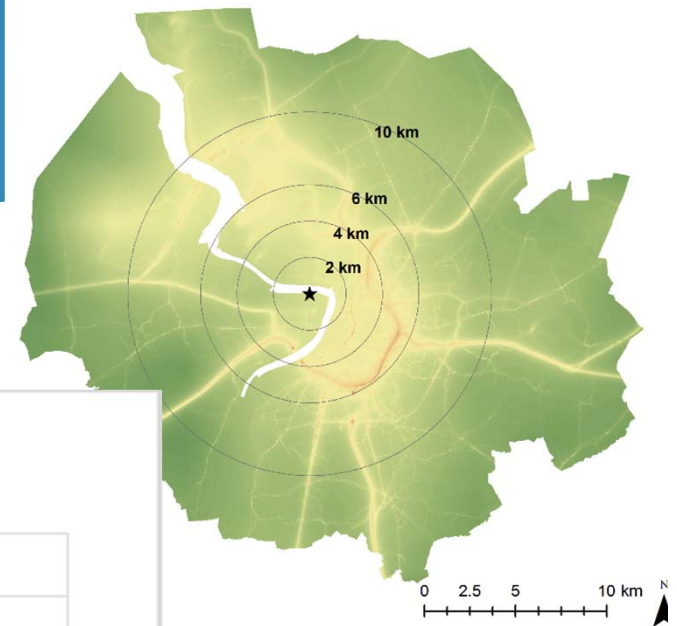


What threshold to choose?
How much should the average exposure in the area of SR be allowed to deviate from the exposure at the measurement station?
xx %?
xx $\mu\text{g}/\text{m}^3$?
How handle hot/cold-spots?
- Should these areas be excluded from the analysis?

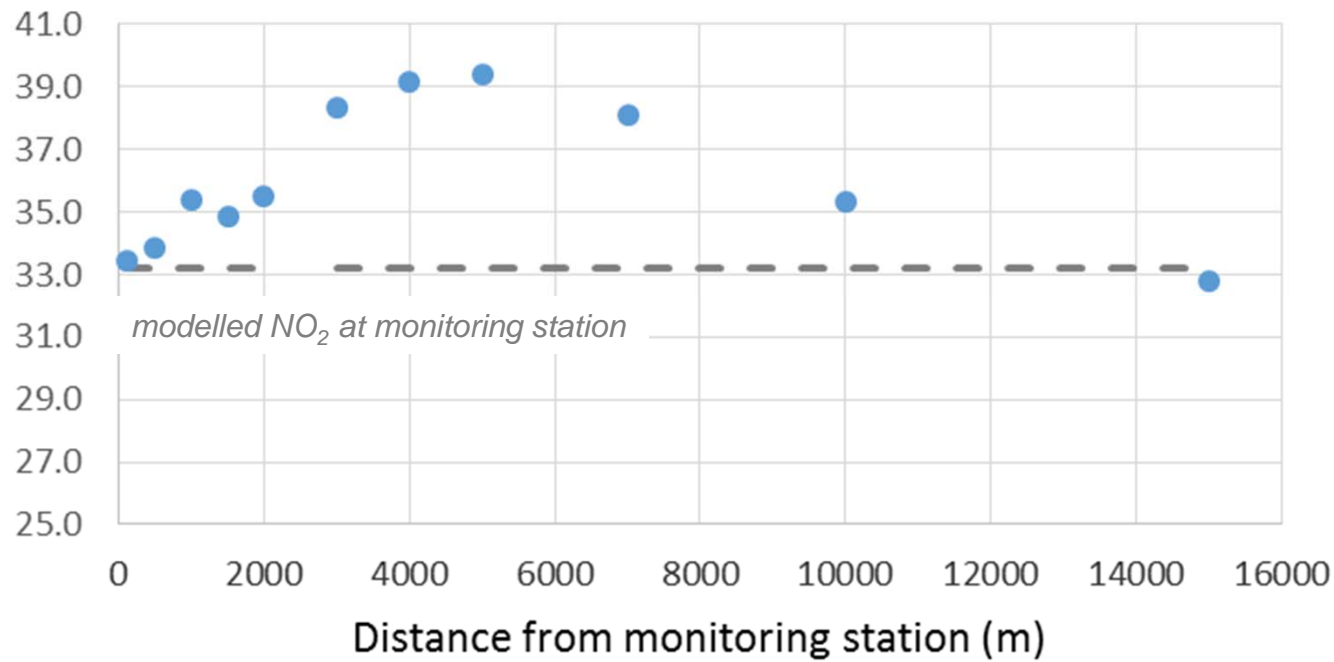


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NO₂



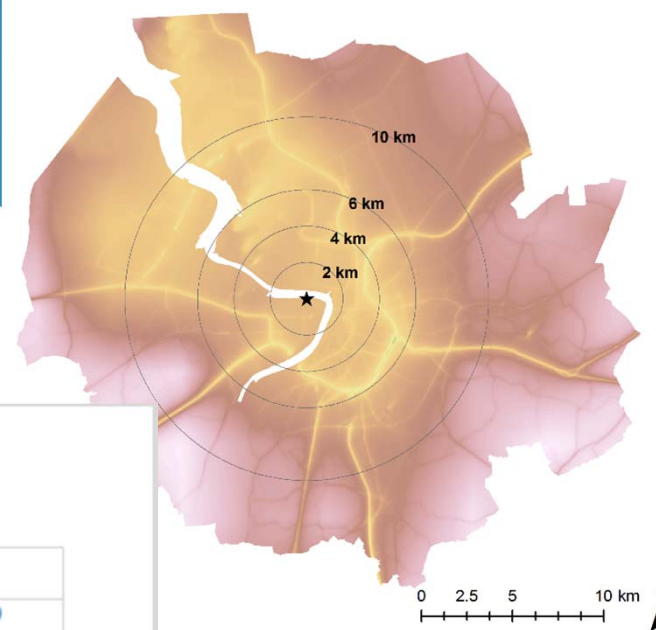
Population-weighted concentration of NO₂



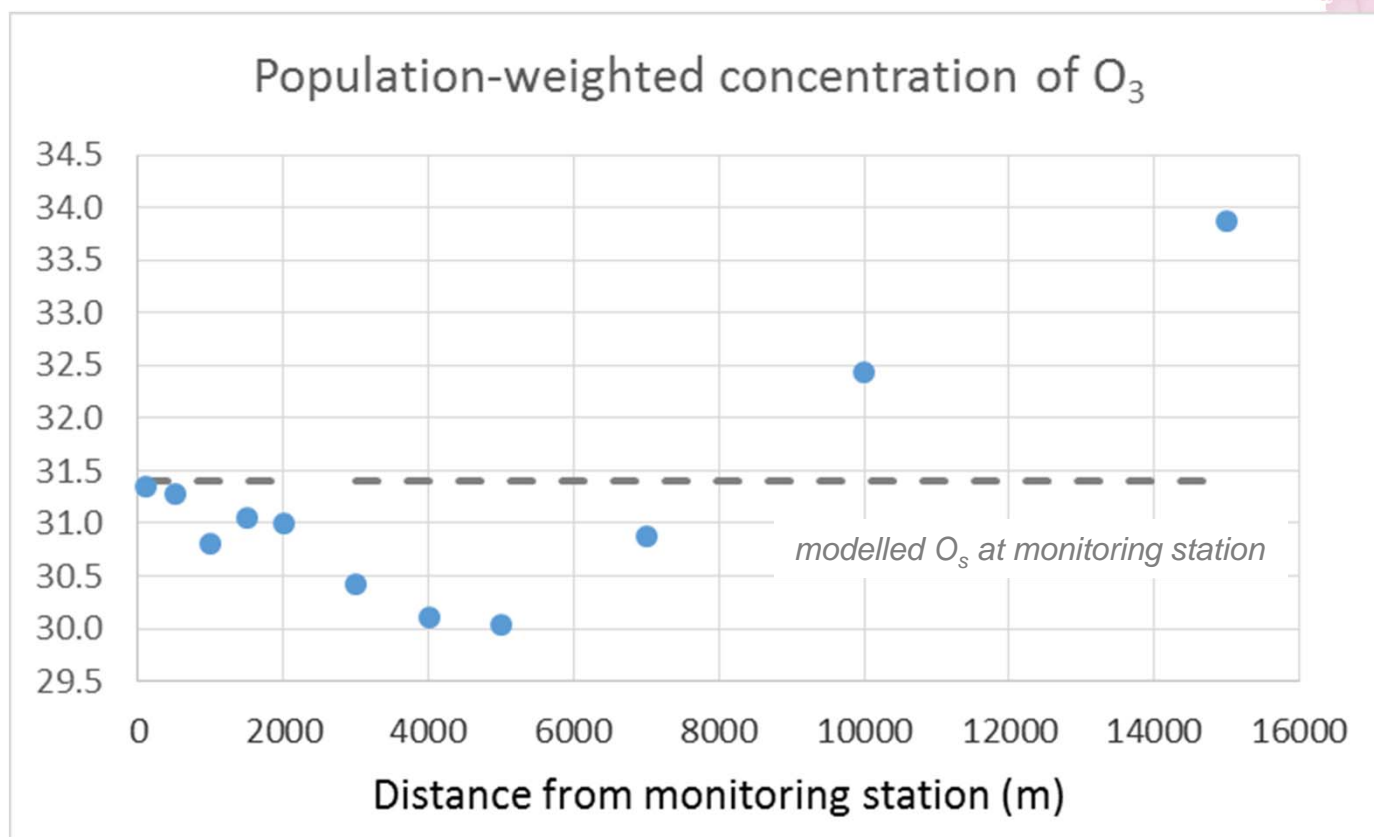
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O₃



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Choice of threshold

Usually we use threshold based on population-weighted concentration. In the Fairmode IE we tested some different thresholds, i.e. modelled mean concentration and standard deviation of the modelled mean concentration within the circular buffer around the station.

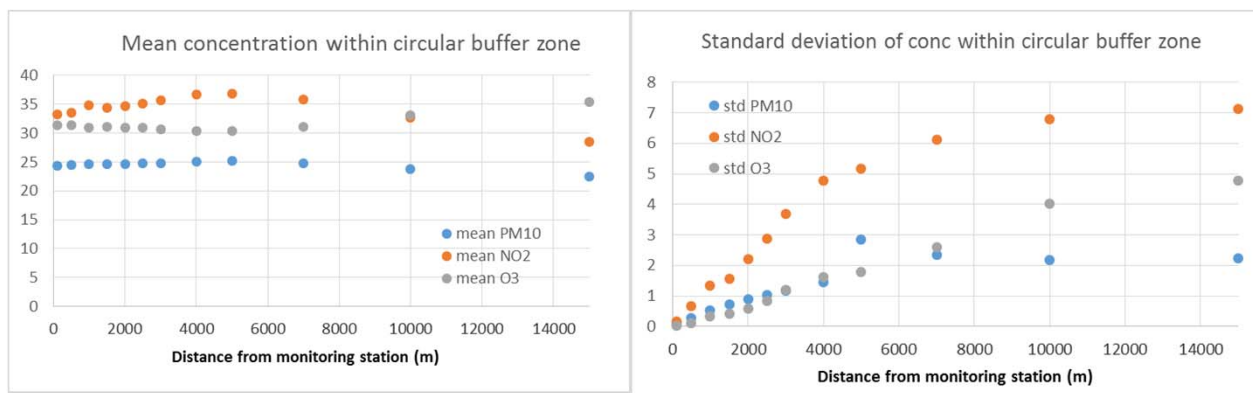
Finally we used following criteria:

Area of SR = circular buffer zone around the station where the standard deviation of the modelled average concentrations (100 m x 100m) within the buffer zone was less than:

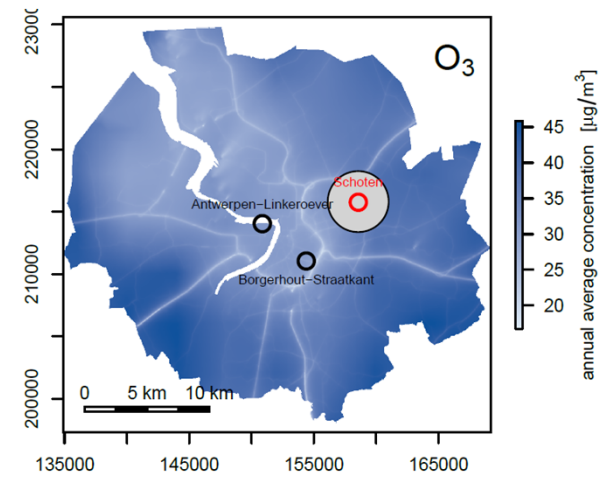
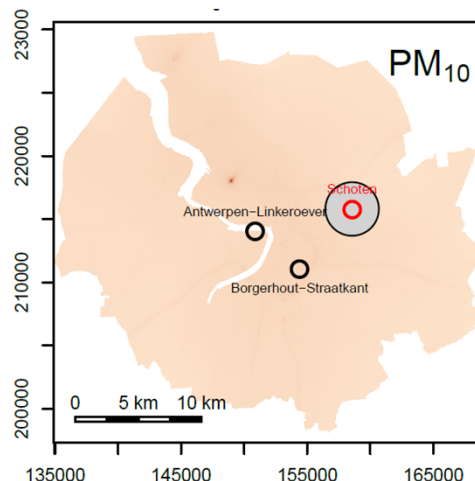
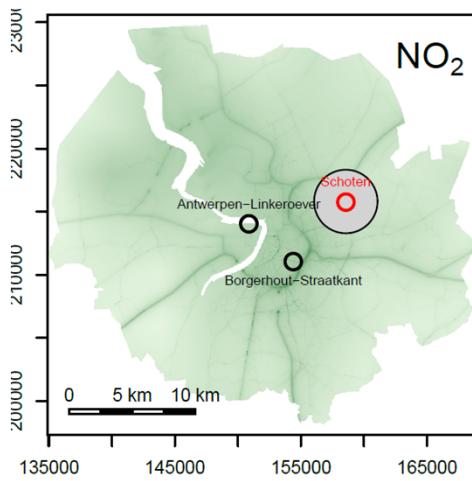
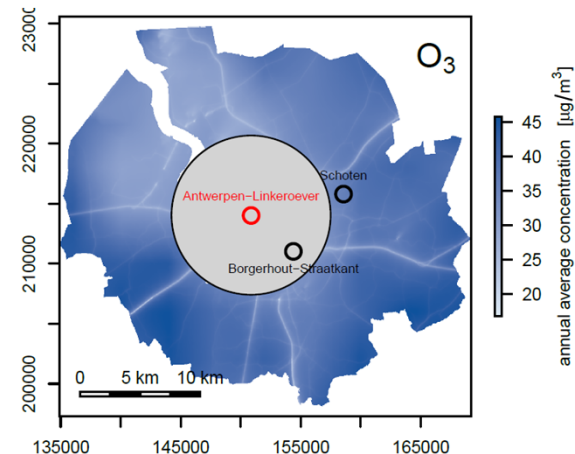
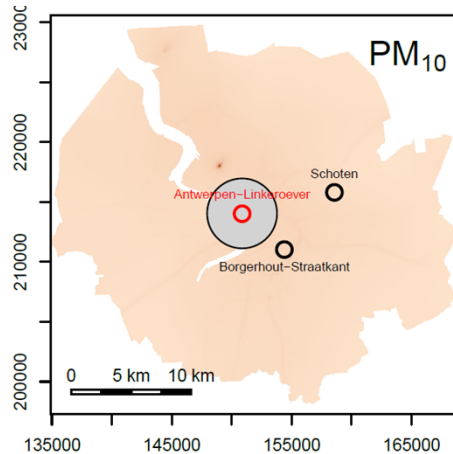
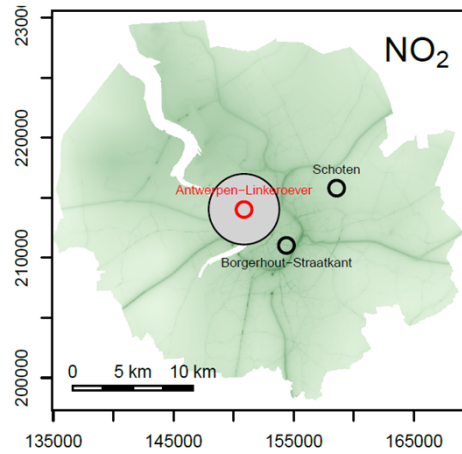
NO_2 : $3.6 \mu\text{g}/\text{m}^3$ PM_{10} : $1.2 \mu\text{g}/\text{m}^3$, O_3 : $2.4 \mu\text{g}/\text{m}^3$.

These thresholds correspond to half of the standard deviation of modelled conc. across the whole Antwerpen region

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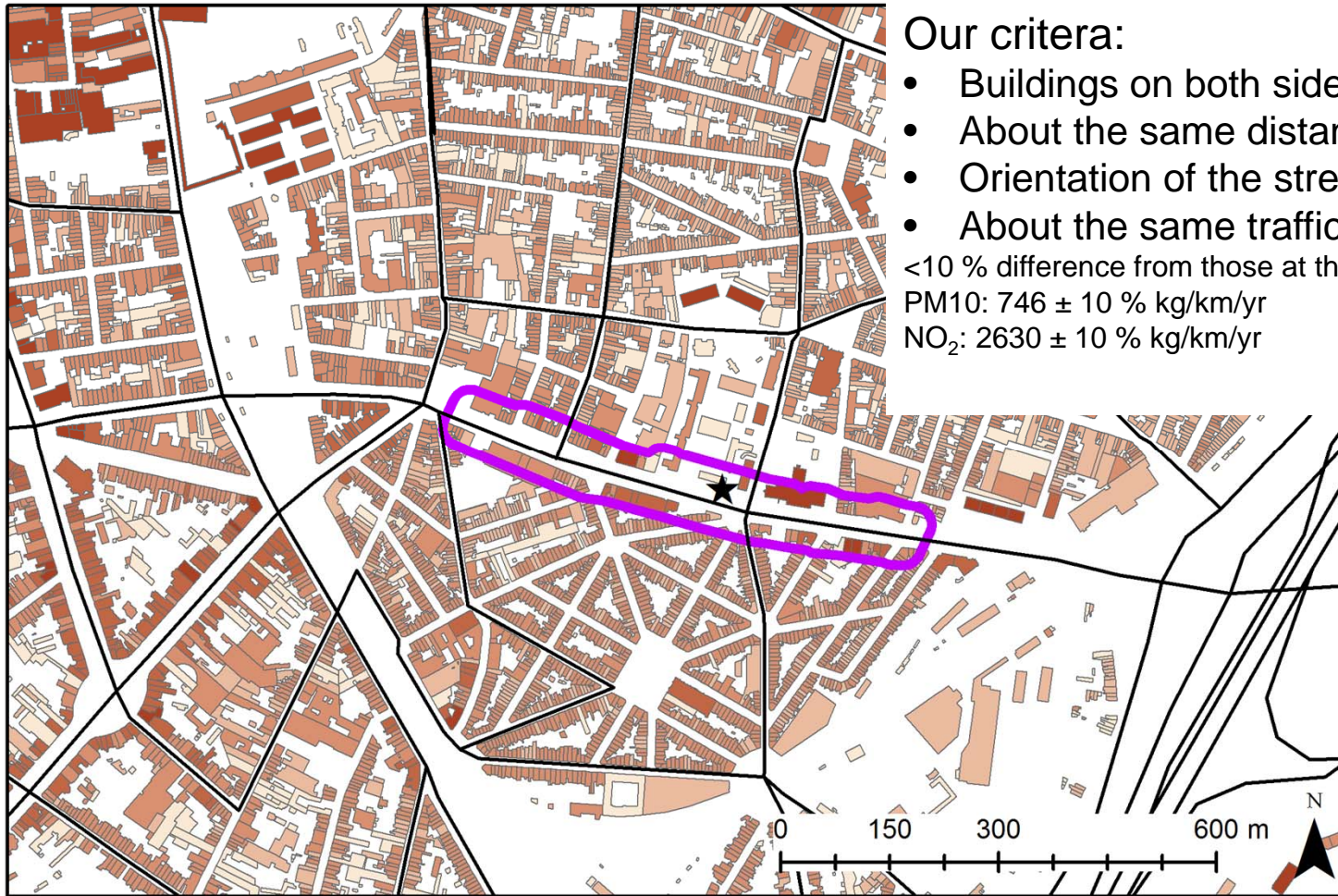
Results for the UB stations



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Analysis Borgerhout-Straatkant



Our criteria:

- Buildings on both sides of the street
- About the same distance between houses
- Orientation of the street (west-east)
- About the same traffic emissions

<10 % difference from those at the measuring station

PM₁₀: 746 ± 10 % kg/km/yr

NO₂: 2630 ± 10 % kg/km/yr

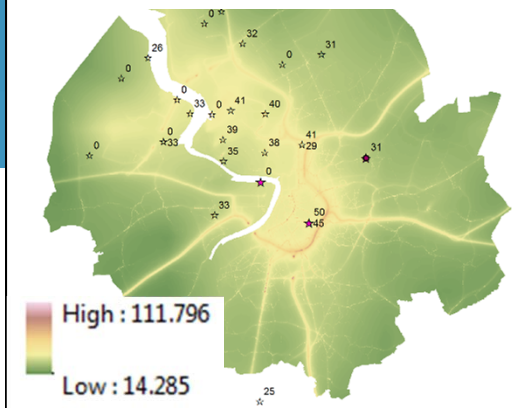


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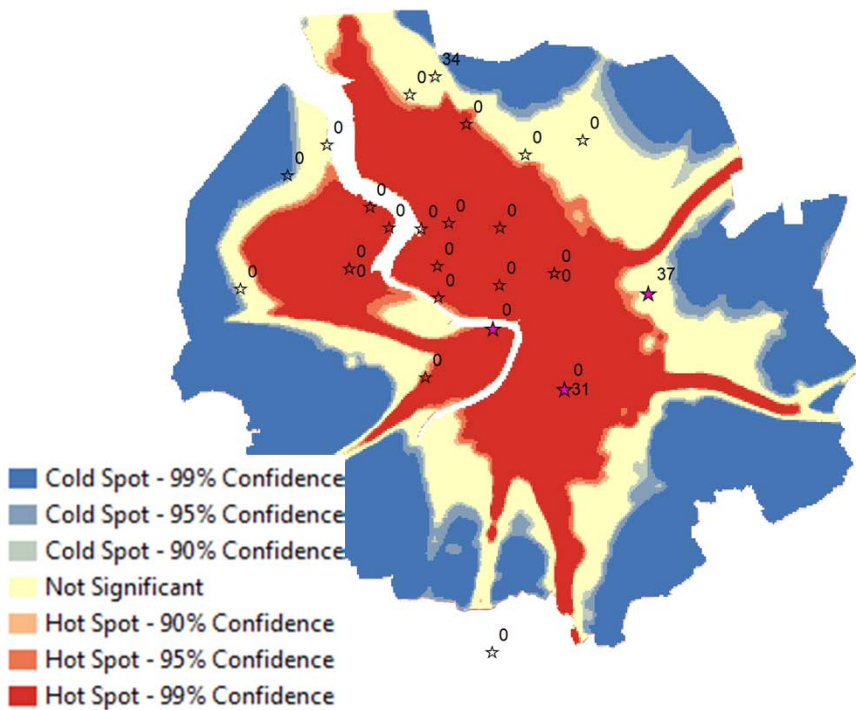
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GIS analysis of modelled NO₂

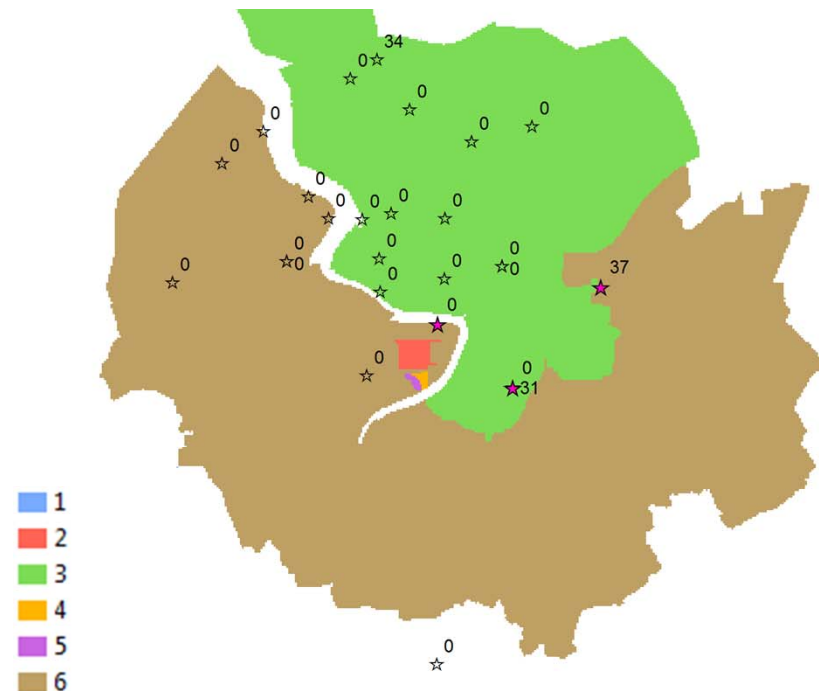
Modelled NO₂ conc



The ESRI ArcGIS [Hot Spot Analysis](#) tool features with either high or low values cluster spatially

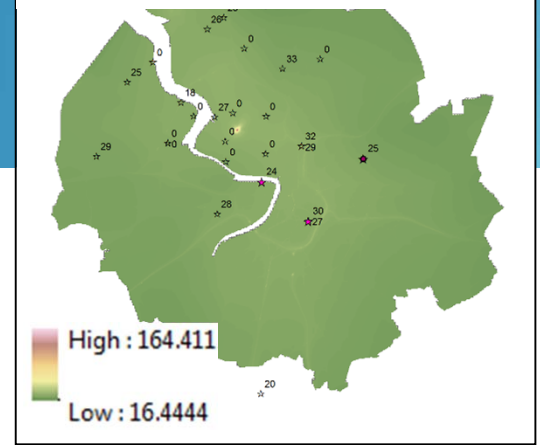


The ESRI ArcGIS [Grouping Analysis](#) tool classification procedure to find natural clusters in your data.

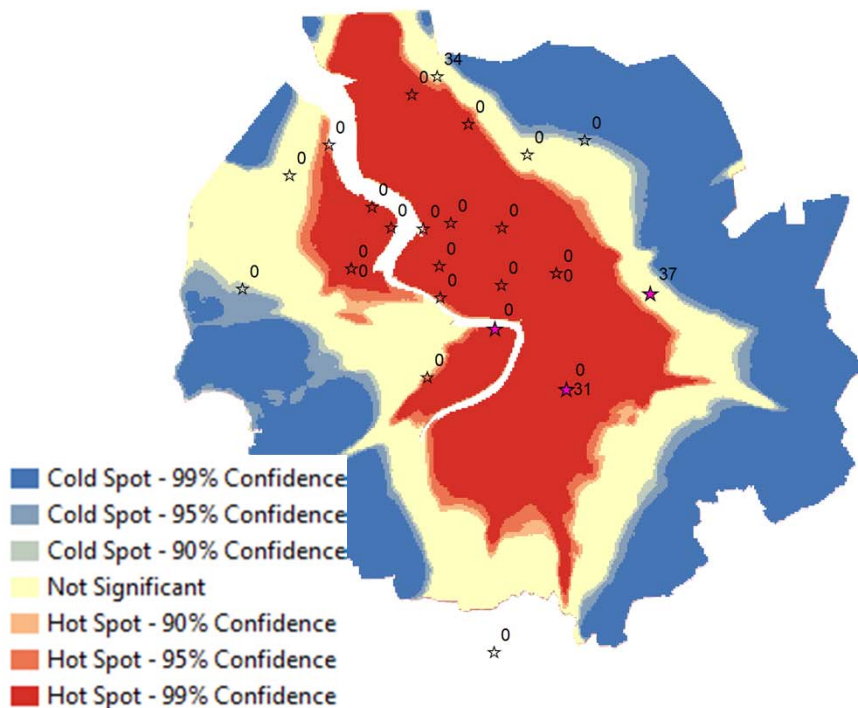


GIS analysis of modelled PM10

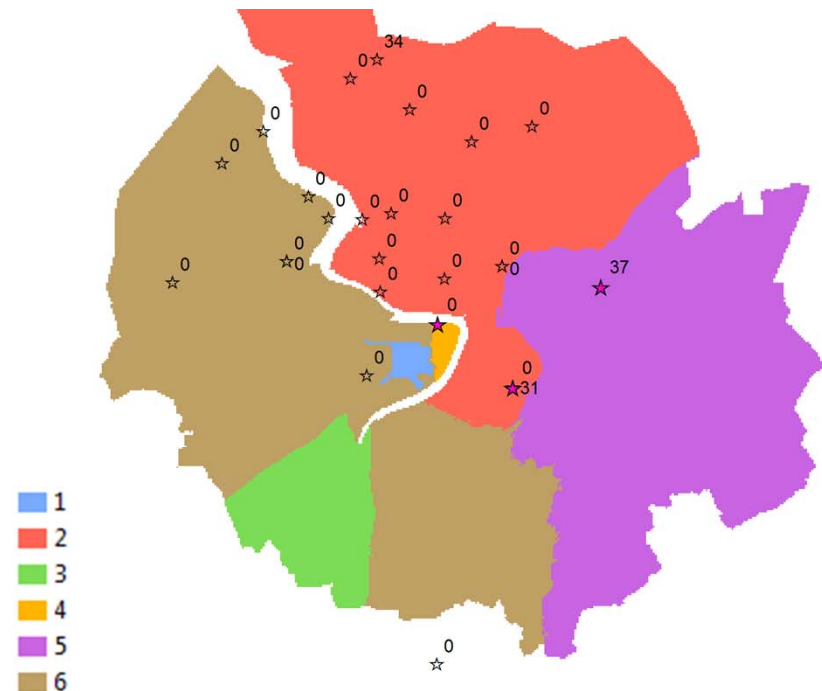
Modelled PM10 conc



The ESRI ArcGIS [Hot Spot Analysis](#) tool features with either high or low values cluster spatially

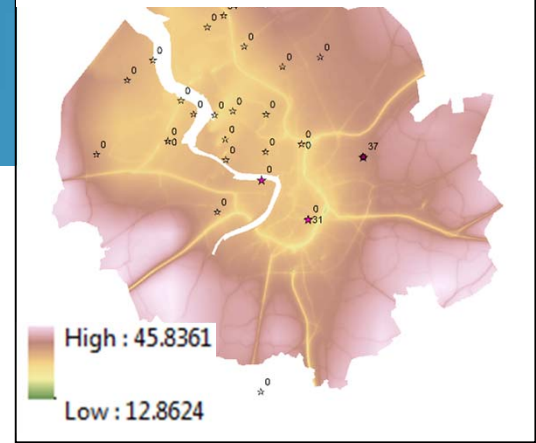


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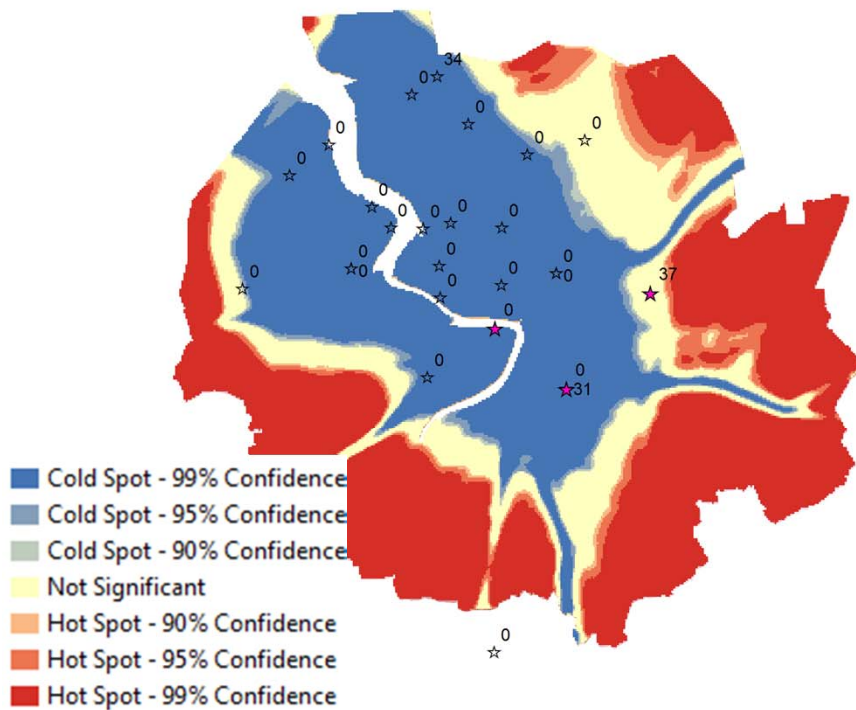


GIS analysis of modelled O₃

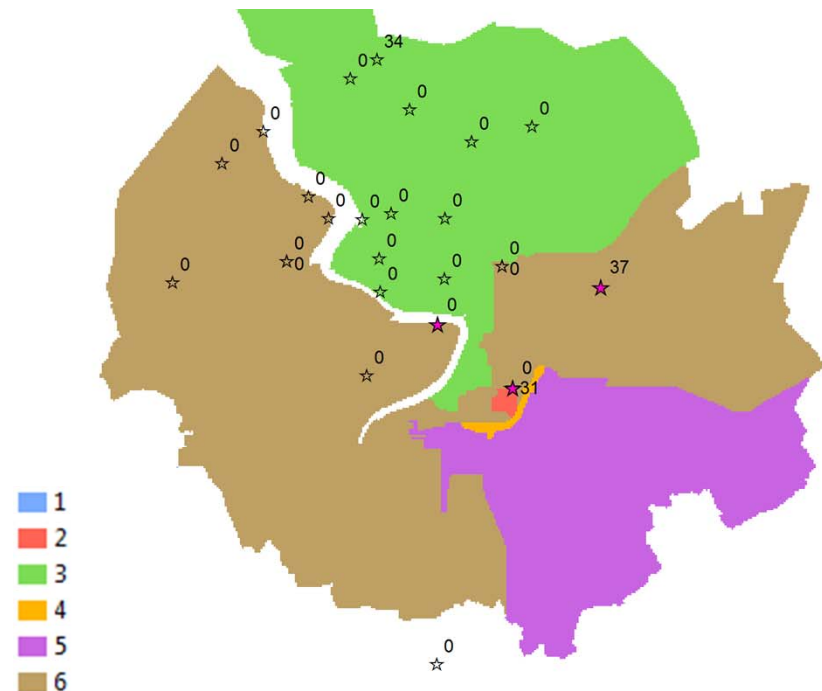
Modelled O₃ conc



The ESRI ArcGIS [Hot Spot Analysis](#) tool features with either high or low values cluster spatially



The ESRI ArcGIS [Grouping Analysis](#) tool classification procedure to find natural clusters in your data.





Scope, objectives and typical use of the selected spatial representativeness (SR) method

- 1) What is the **scope** and the detailed **objectives** of your SR method used in the exercise?
To evaluate the exposure for health assessment and motivate the choice of location of our urban background station location.
- 2) In which **context** do you typically use this method?
See answer above.
- 3) Are there **other SR methods** that you would typically use in your work on SR assessments?
No.
- 4) How does the use of your method(s) relate to local / regional / national / EU-wide **regulatory and /or legal obligations**?
To motivate our choice of urban background station location in Stockholm. The station is located at a roof-top, which is to far up according to the regulations (8 m max).



Maturity and fitness to purpose of the SR method used in the exercise

- 1) How many **years of experience** do you have with the specific SR method used in the exercise?

Approx 10 years (UB).

- 2) How many **years of experience** do you have with evaluating SR in general (including experience with other methods)?

Approx 10 years (UB).

- 3) How would you rate the **maturity of the SR method** you have used in the exercise?

(This may reach from "rather experimental" to "well established" – please also comment on the fitness to purpose of your method.)

Urban background: Our method is very simple but for our purposes to check how representative our urban background station is regarding Stockholm's exposure to air pollution, it works well.

Maturity: established, but choice of which threshold to use is experimental.

Traffic site: we really have no method but our philosophy is to measure where we think we have exceedances of AQS and supplement this with modeling.

- 4) Is it possible to **apply your method by other institutes** using the tools you have developed?

(e.g.: Are your tools available to others? Is there a copyright concern? What is the level of difficulty and necessary skills for their implementation?)

Yes.



Similarity criteria & definition of Spatial Representativeness (1)

- 1) Please summarize the underlying **definition of SR** you have used in the exercise.
See answer to question 2) below.
- 2) Please summarize the underlying **similarity criteria & threshold parameters** you have used.

Traffic station:

- Buildings on both sides of the street
- About the same distance between houses
- Orientation of the street (west-east)
- About the same traffic emissions
 - ❖ <10 % difference from those at the measuring station
 - ❖ PM10: 746 ± 10 % kg/km/yr
 - ❖ NO2: 2630 ± 10 % kg/km/yr

Background stations:

Circular buffer zones around each measuring station.

Threshold parameters:

Area of SR = buffer zone around the station where the standard deviation of the modelled average concentrations (100 m x 100m) within the buffer zone was less than:

NO₂: 3.6 µg/m³ PM10: 1.2 µg/m³, O₃: 2.4 µg/m³.

- 1) Are there **other SR definitions** and / or **similarity criteria** you would typically use in your work on SR?

No.



Similarity criteria & definition of Spatial Representativeness (2 – some details)

- 1) Are the boundaries of your spatial SR areas constrained **exactly**, or did you add some additional **buffers or safety factors**?

We added a 25 m buffer around the area of SR around the traffic site. This to take into account that people living in the building with entrances towards the street are exposed to the concentrations of pollutants in the street canyon.

- 2) Can SR areas of different stations **overlap** or are they considered to be **exclusive** by principal?

Yes, they can overlap depending on how wide criteria for example by health assessment.

- 3) Are your similarity criteria applied **one sided** or **two sided**?

(i.e.: Are you evaluating deviations only towards higher values, or towards both higher and lower values?)

Two-sided.

- 3) Within your estimated SR areas: is spatial representativeness guaranteed for locations of **all station types**, or only for locations of **station types identical** to the type of the central station?

(e.g.:

Within the SR areas estimated for the urban background stations Schoten and Antwerpen-Linkeroever: is spatial representativeness guaranteed for locations of all station types? Or for locations of background station type only?

Within the SR area estimated for the urban traffic station Borgerhout: is spatial representativeness guaranteed for locations of all station types? Or for locations of traffic station type only?)

Only for station types identical to the type of the central station (this because we use different methods dependent of type of station).



Input data

- 1) Please summarize which part of the **input dataset** you have used in the exercise.
Traffic station: Road network, traffic emissions, building polygons
Urban background: Modelled concentrations (100 m x 100m), (population data)
- 2) Did you use **additional data**, not contained in our dataset?
(e.g., Street View pictures, maps from other sources, etc.)
No.
- 3) How suitable did you find the **Antwerp dataset** for your method? / How suitable would you rate your method to be for this type of dataset?
It was sufficient.
- 3) Did you **miss** any type of data / information in this dataset?
Traffic composition, e.g. share of heavy-duty traffic, traffic volume.
- 4) How does the dataset of the exercise compare to the **data you would more typically use** for you work on SR?
Quite comparable, but less information about traffic.