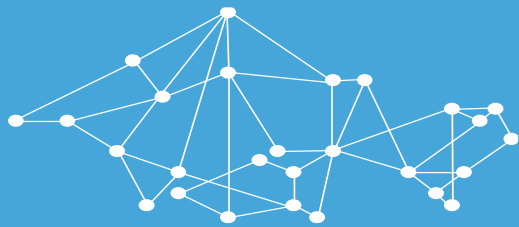# FAIRMODE
Forum for air quality modelling in Europe

CT8 – #1:
SPATIAL REPRESENTATIVENESS OF MONITORING STATIONS

TOWARDS RECOMMENDATIONS

STIJN JANSSEN, LEONOR TARRASON

» Summary of the CT8 session at the Technical Meeting (Stijn)

» Review of the proposed SR methodology (all)

» Topics for further analysis (all)

» EU wide benchmark data set with uEMEP (Bruce)

» Towards a FAIRMODE recommendation (all)

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Test the Spatial Representativeness recipe and provide input for FAIRMODE Recommendations

- Make use of your existing modelling results

- Apply the recipe to delineate an SR area for a number of "interesting" stations in your country (rural, urban background, traffic, industrial)

- *Optional: perform your own sensitivity analysis on threshold values, contiguity, similarity criterion, lower cut-off, station type*

- *Optional: Compare these SR areas to results of other SR assessment methodologies used in your region/country*

- Discontiguous SR area

- Similarity criterion: annual mean concentrations

- Threshold value: 20% with absolute cutoff for low concentrations

- Limit SR area to the IPR AQ zone

- NO_2, PM_{10}/($PM_{2.5}$), O_3

→ Use modelled concentrations at station location (assuming bias is small → fit-for-purpose model)
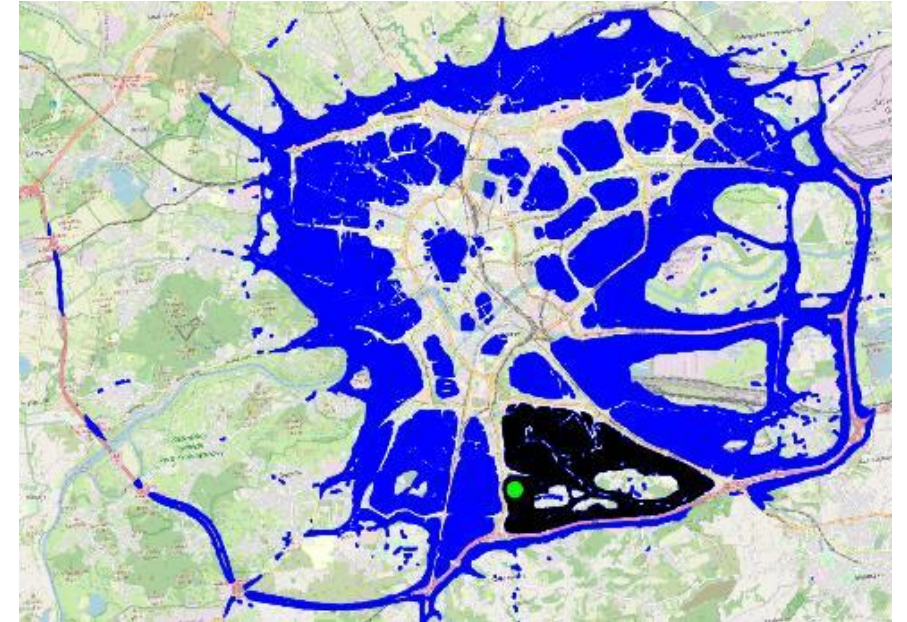
FAIRMODE
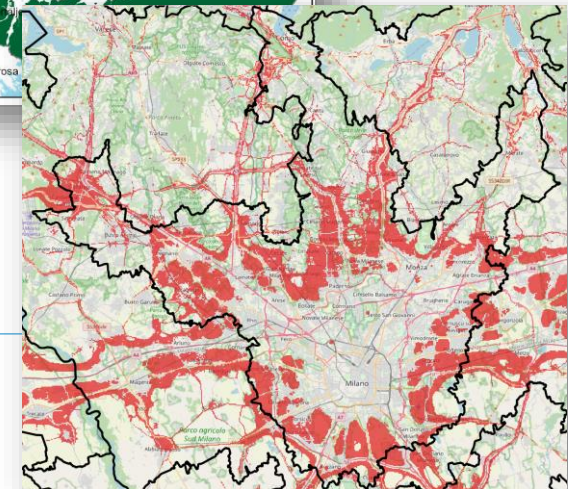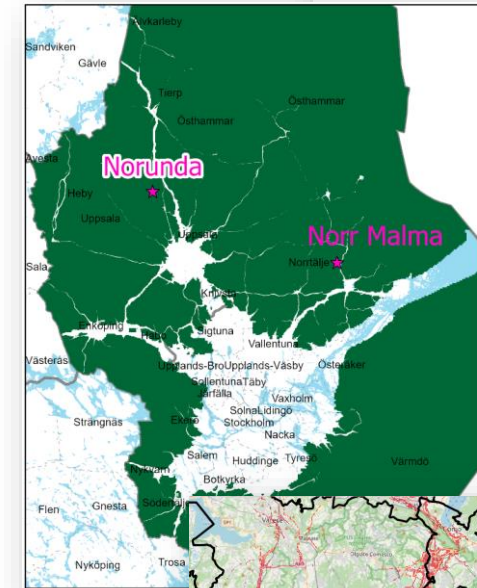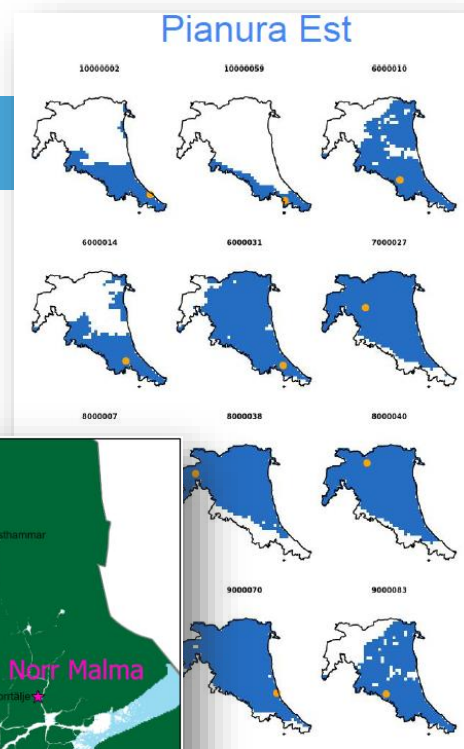Forum for air quality modelling in Europe

PARTICIPANTS CT8.1

Name	Country/Region
Vasiliki Assimakopoulou, Kyriaki-Maria Fameli	Athens
Doreen Schneider, Christiane Lutz-Holzhauer	Baden-Württemberg
Andreas Kerschbaumer	Berlin
Michele Stortini, Roberta Amorati	**Emila Romagna**
Bruce Rolstad Denby, Eivind Grøtting Wærsted	**Norway / Europe**
Alicia Gressent	France
Bonafè Giovanni	**Friuli Venezia Giulia**
Stephan Nordmann	**Germany**
Antonio Piersanti	Italy
Jutta Geiger	North Rhine-Westphalia
Grzegorz Jeleniewicz	**Poland**
Alexandra Monteiro	Portugal
Angela Morabito, Ilenia Schipa, Francesca Intini	Puglia
Susanne Bastian, Uwe Wolf, Martina Strakova	Saxony
Katrin Zink	Schleswig-Holstein (Northern Germany)
Fernando Martin	**Spain**
Kristina Eneroth	**Stockholm County**
Matthew Ross-Jones, Hilma Engholm	**Sweden**
Bianca Patrizia Andreini, Chiara Collaveri, Francesca Calastrini, Caterina Busillo, Francesca Guarnieri	**Tuscany**

The good news:

» Spatial Representativeness is essential information of a monitoring station and links to many elements in the AQD

» Models become fit-for-purpose to assess SR at all spatial scales and all station types

» FAIRMODE has a much more harmonized view on the subject than few years ago

» So... we're making significant progress. Eventually!

→ thanks to all the enthusiastic participants for their contributions

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Statement by Stephan Nordmann

What is the reason for this approach? According to Annex III B in the AQD (macroscale siting) representative areas of sampling points are relatively unspecific (e. g. several km² for background sites).
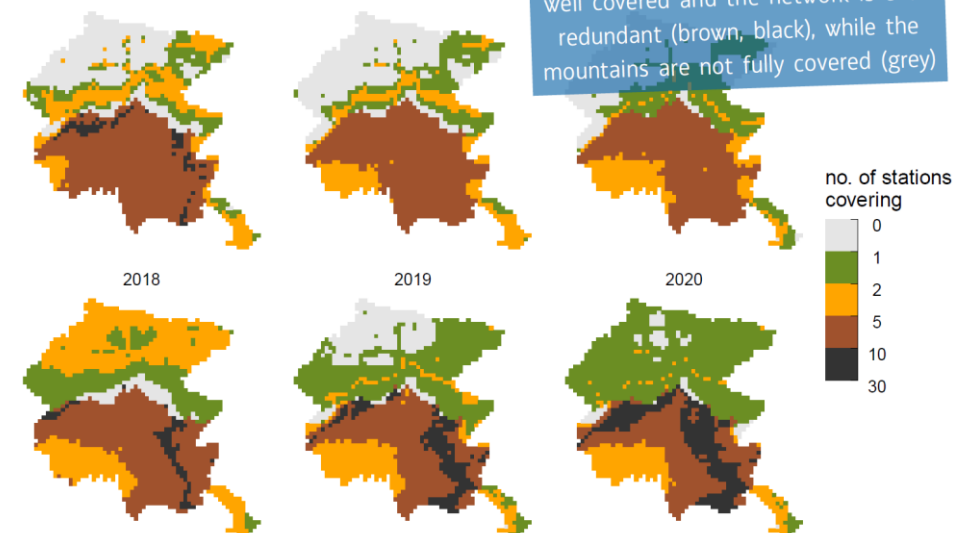
➢ Is it really necessary to have such detailed information about the representative area?

➢ What question should be answered with that?

➢ Is it even possible to give such a detailed information, because the conditions around the sampling points are changing (e. g. meteorology)?

→ SR is requested via e-Reporting as an indicator of a monitoring station → formal obligation under AAQD

→ SR application domains:
　　→ Exceedance situation indicators
　　→ Population exposure
　　→ Model validation & data assimilation
　　→ Network design

we can overlay the SR regions of many stations in order to assess the coverage and redundancy of a monitoring network; in FVG the plain is well covered and the network is even redundant (brown, black), while the mountains are not fully covered (grey)

spatial representativeness coverage
model: KED, pollutant: PM10, index: annual average

2015　　2016

2017

2018　　2019　　2020

no. of stations covering
0
1
2
5
10
30

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Source: Giovanni Bonafè

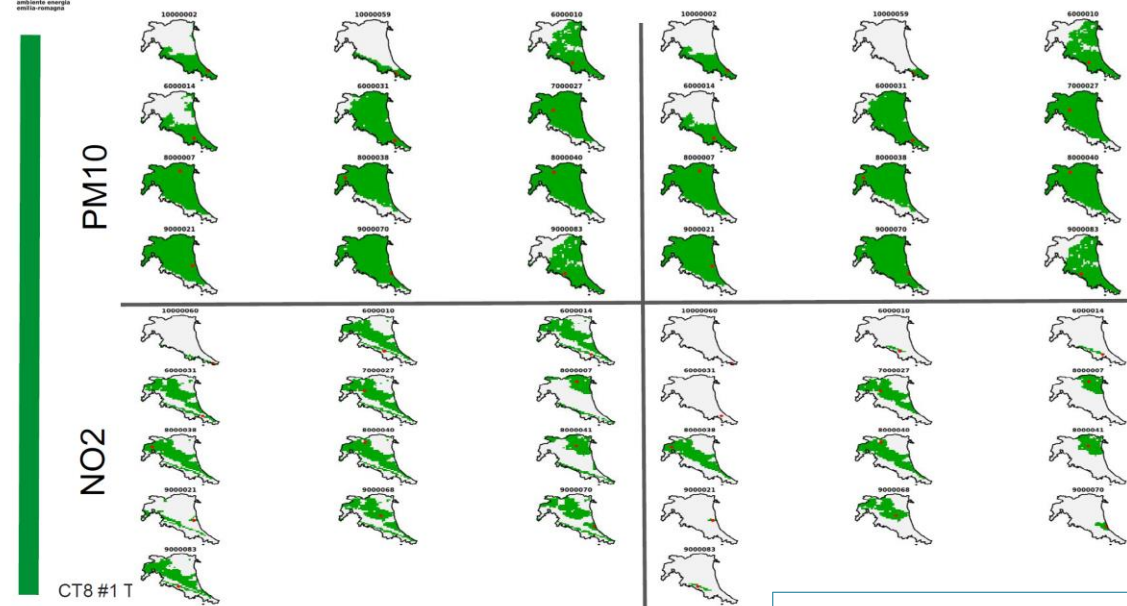## OPEN ISSUES

» Contiguous vs discontiguous area's
  » Most relevant for NO2, less for PM10
» Boundaries based on AQ zone → if needed can be made smaller (expert based correction)
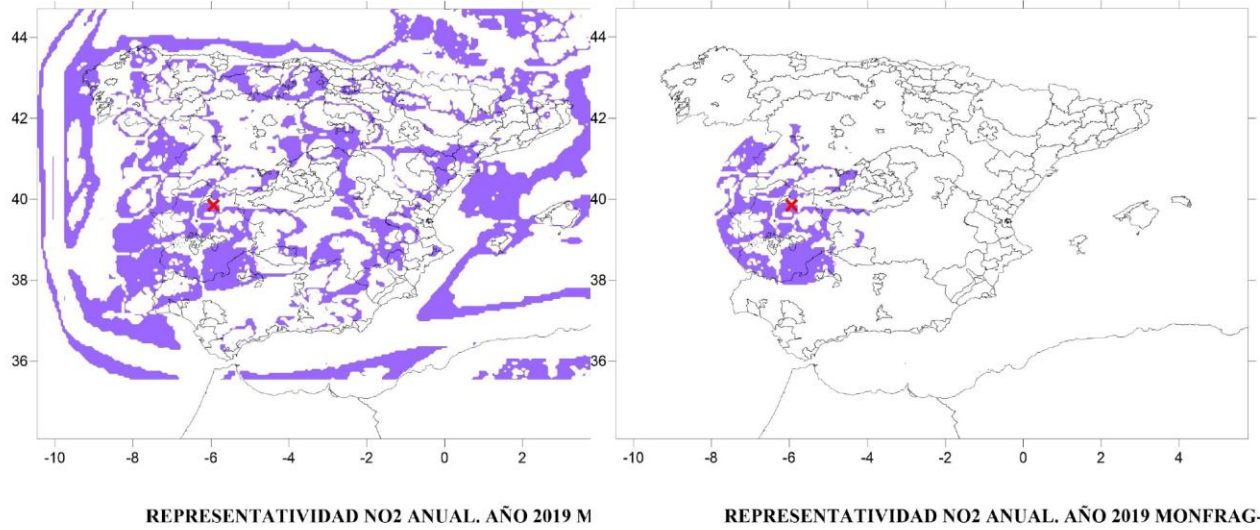 » Not always useful → less sensitive for lower thresholds
  » Any alternative?
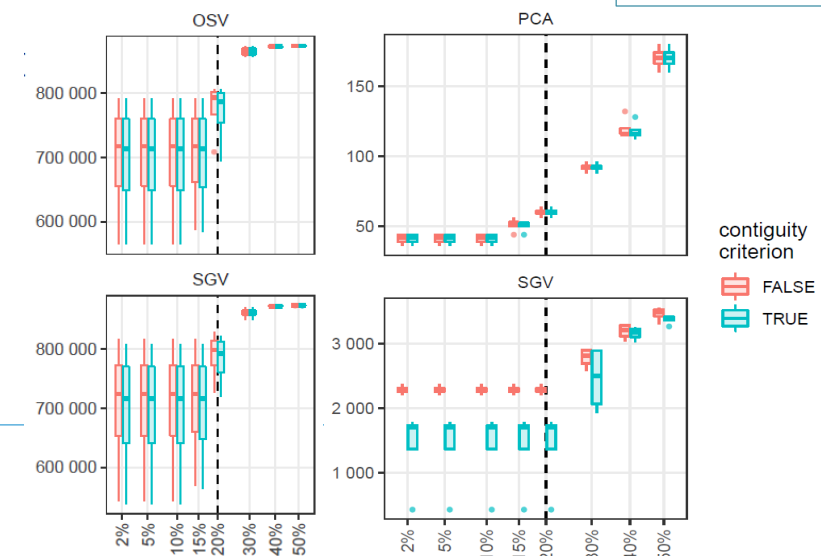

Source: Roberta Amorati

A vs A+. NO$_2$ annual
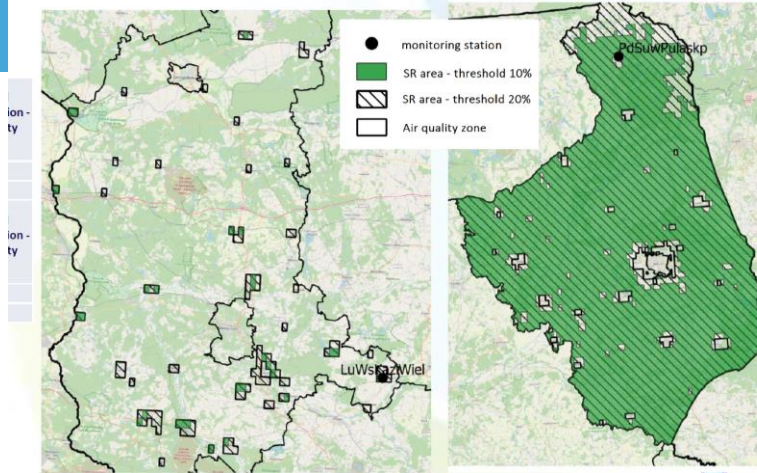
Source: Fernando Martin

Source: Giovanni Bonafè

OPEN ISSUES

» Threshold (or tolerance) in similarity criterion:

 » 5% - 20% → 10% seems to be a good compromise but what with measurement and model uncertainty?
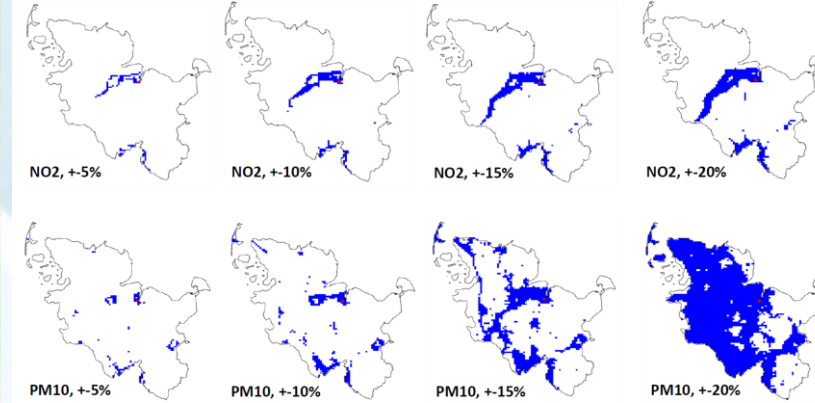
 » Pollutant dependent?

 » Station type dependent?

Source: Grzegorz Jeleniewicz

Source: Stephan Nordmann

PM2.5

LLUR Schleswig-Holstein

Traffic Station Kiel Theodor-Heus Ring

NO2, +-5% · NO2, +-10% · NO2, +-15% · NO2, +-20%

PM10, +-5% · PM10, +-10% · PM10, +-15% · PM10, +-20%

Spatial representativeness area shown as a fraction of the air quality zone area

Source: Bruce Denby

Torkel Kn, Stockholm
- PM10 yearly mean: 11.2 µg/m³
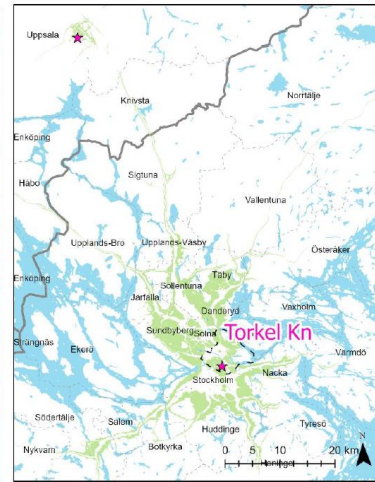- ± 20 %: 8.9 – 13.4 µg/m³

Torkel Kn, Stockholm
- PM10 yearly mean: 11.2 µg/m³
- ± 10 %: 10.1 – 12.3 µg/m³

Torkel Kn, Stockholm
- PM10 yearly mean: 11.2 µg/m³
- ± 5 %: 10.6 – 11.7 µg/m³

Source: Kristina Eneroth
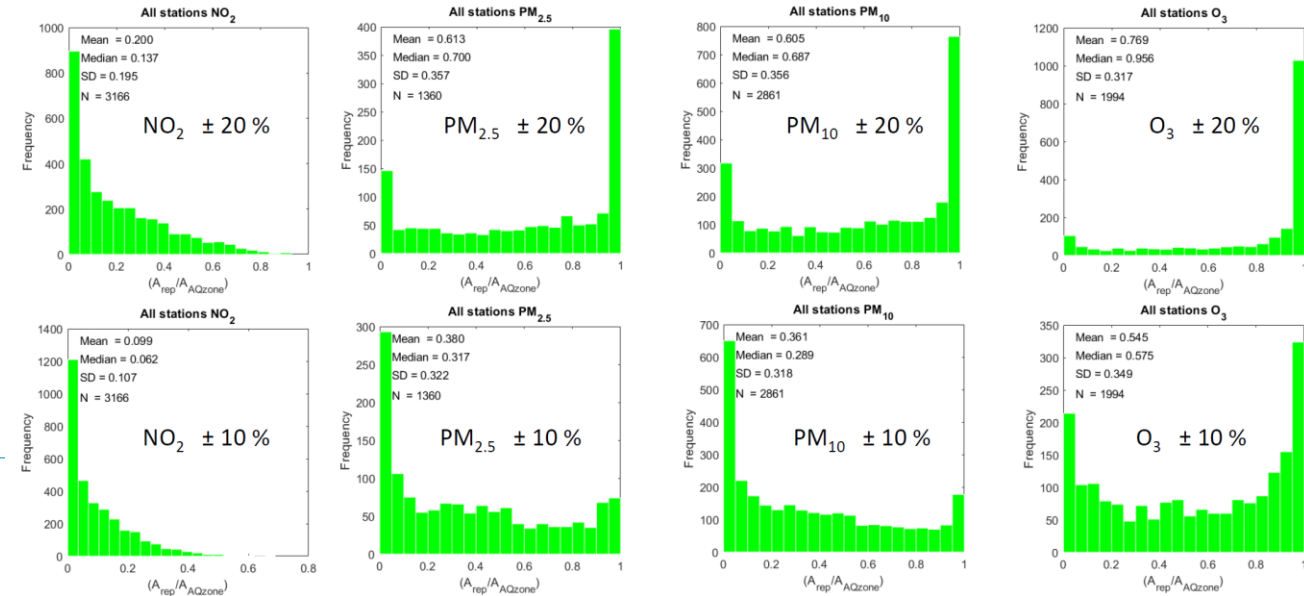
OPEN ISSUES

» Threshold (or tolerance) in similarity criterion:
  » Relative or absolute threshold (or combination)?
  » Arguments so far:
    » Relative criterion → allows for a better comparison between stations, but problematic for low (and high?) concentrations
    » Absolute criterion → relevant for low concentrations
  » Combination: increases the SR area in the low ranges
  → Low cut off (2 µg/m³?)
  → 10% ?
  → High level concentrations → higher value needed to reflect complexity in urban environment → 20% ?
  → test measurement uncertainty curve of MQI
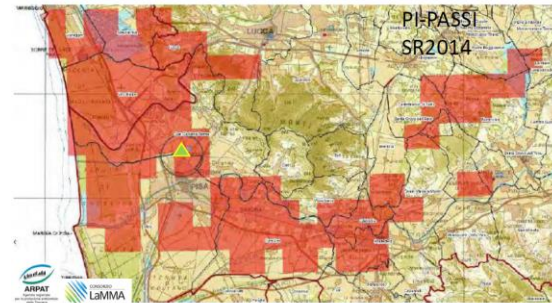 → Can variability in the SR area be used as criterion?
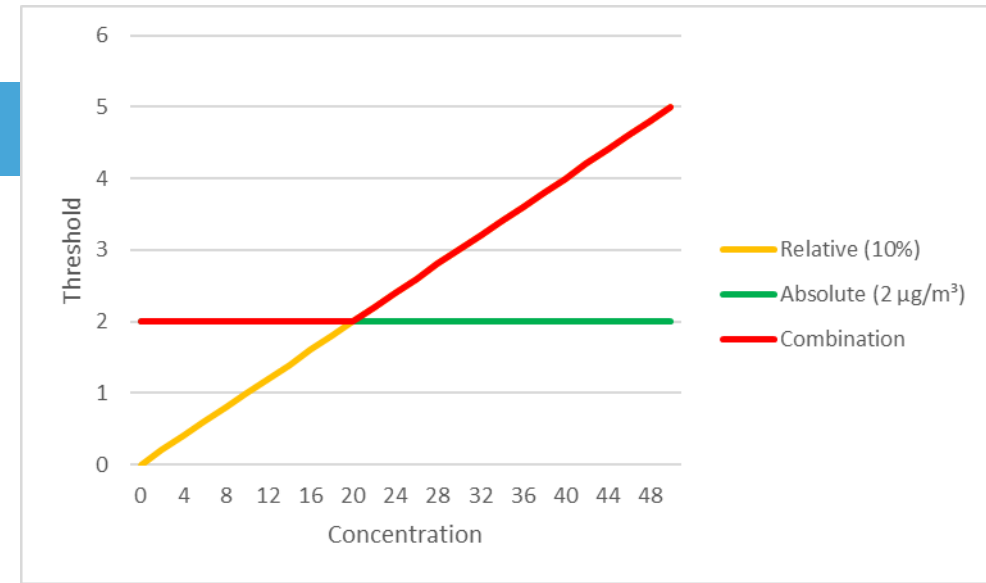
RESULTS-NO2
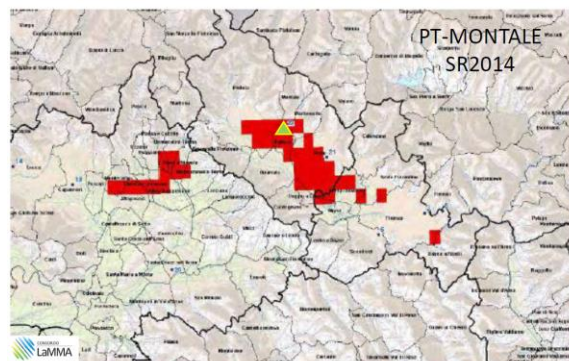
Current SR of the station point PT-MONTALE (red pixels)

no2 – PT-MONTALE – 2015 (cutoff 2)
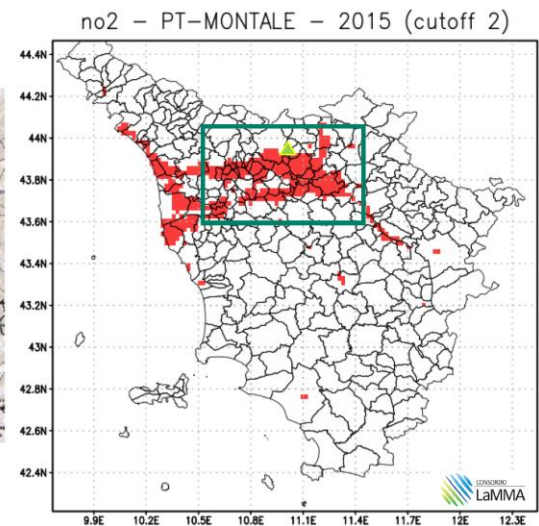
New SR of the station point PT-MONTALE (red pixels) with a threshold of 20% and cutoff 2µg/m³

RESULTS-PM10

Current SR of the station point PI-PASSI (red pixels) The coastal area in the PISA surroundings, in the new SR, it seems to be is represented by an inner station point (PI-MONTECERBOLI) with a very different geographical properties.

pm10 – PI-MONTECERBOLI – 2015 (cutoff 5)
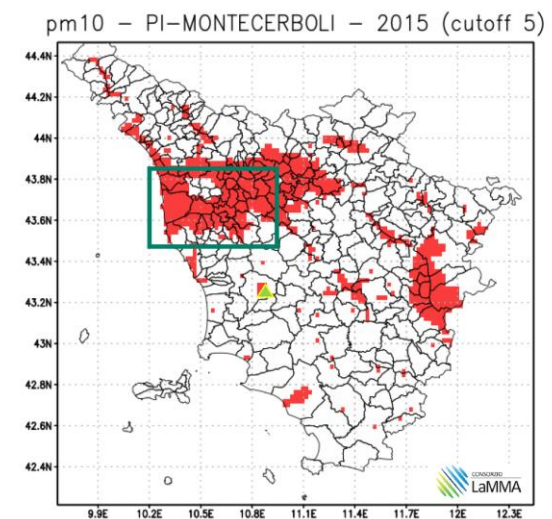
New SR of the station point PI-MONTECERBOLI (red pixels) with a threshold of 20% and cutoff 5µg/m³

Source: Francesca Guarnieri

» Similarity criterion: simple "annual mean" or more complex definitions: source dependent, seasonal mean, percentiles…?

→ let's start with something simple but maybe not sufficient!

→ More tests welcome! Both on sources and percentiles → application domain (eg. exceedance estimation) might be leading here

→ Source information is relevant for AQ Planning

→ Source info is relevant for communication to the public (expert corrections could be first step)

NO_2 annual mean, Umeå V. Esplanaden (traffic site)

Annual mean (2016): 33.9 $\mu g/m^3$

Representative area ±20%
27.1 – 40.7 $\mu g/m^3$

Representative area ±30%
23.6 – 44.1 $\mu g/m^3$

Representative area ±40%
20.4 – 47.5 $\mu g/m^3$

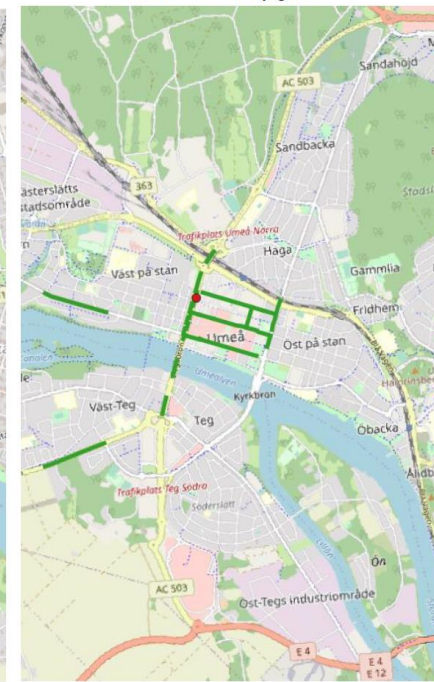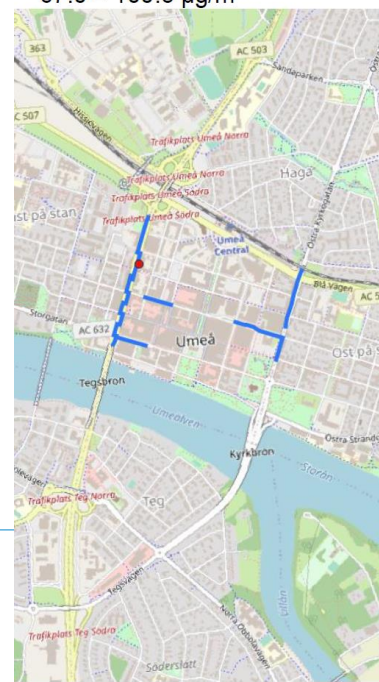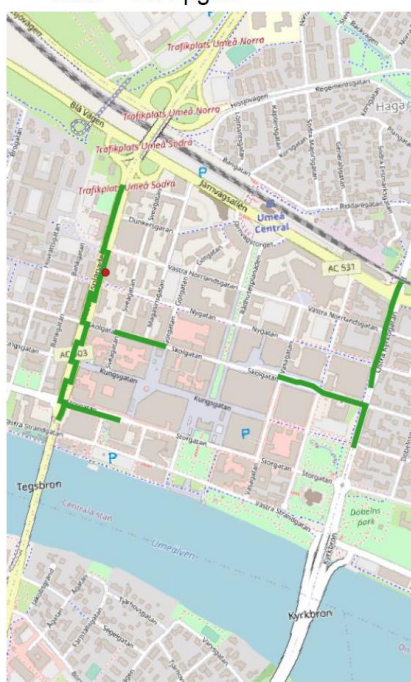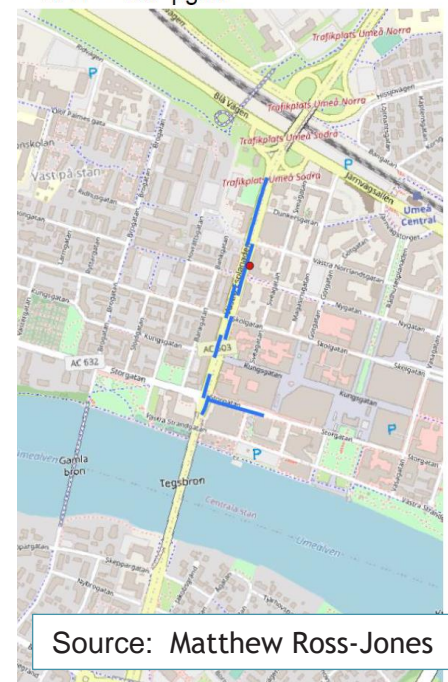NO_2 daily mean, Umeå V. Esplanaden (traffic site)

98th percentile daily means (2016): 83.7 $\mu g/m^3$

Representative area ±20%
67.0 – 100.5 $\mu g/m^3$

Representative area ±30%
58.6 – 108.8 $\mu g/m^3$

Representative area ±40%
50.2 – 117.2 $\mu g/m^3$
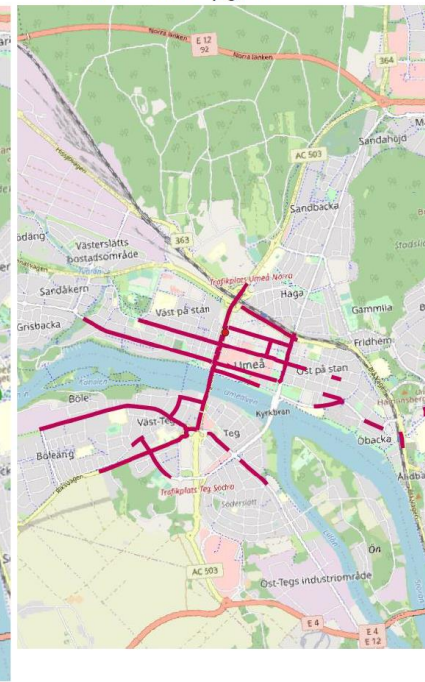
Source: Matthew Ross-Jones

» Inter-annual variability of the SR area: a matter of fact or a problem?
  → it is just a reality !??
  → depends on the application domain
    → exceedance situation estimation → annual reporting requires annual SR values/assessment
    → monitoring design → inter-annual variability should be averaged out
  → needs further testing, impact of lower cuttof might be important here as well!

» Modelling requirements:
  » model (resolution) dependency? → station type puts requirements for spatial resolution of the model. Model should be able to describe what is happing in "reality" → it is prefered to base evaluation on MQO (if possible)
  » bias between model and station values → what is acceptable? → model should be fit-for-purpose !??
    → traffic stations might be problematic due to bias → if you miss a source
    → Put a cutoff on the bias that is acceptable, link with MQI/MQO
    → Test on the bias/MQO (per station ?)

» Benchmarking with a EU wide data set based on uEMEP (Bruce)
  » Compare SR area per station for all EU → data available in an Excel sheet for 10%, 20% (incl cutoff of 2µg/m³) for NO2, PM10, PM2.5 and O3 → only values for area, no shape files

» New tests:
  » MQO curve for thresholds
  » Impact of lower cutoff
  » Different cutoffs for rural/urban & traffic stations?

  » MQO requirement on model/station bias → minimum level required?

  » Inter-annual variability → how big is this?

  » (Source dependency → feasible? What does it bring extra?)

» Recommendations:
  » What do we report? What is managble? Should be part of the recommendations → shape files?

» SR area is defined:
  » in a discontiguous approach
  » limited by the AQ zone → if needed the area can be reduced (e.g. based on expert opinion)

» SR similarity criterion based on annual mean concentration (for the time begin), but:
  » **Test the possibility of a source specific SR** → important for e.g. AQ planning

» SR threshold as a 15% relative value with lower cut-off, but:
  » Test various cut-off values (e.g. 2 – 4 µg/m³)
  » **Test the measurement uncertainty curves of the FAIRMODE MQI**

» SR inter-annual variability (e.g. due to meteo effects) is a reality, but:
  » Relevance depends on the application domain → **more testing to assess the impact**

» SR assessment requires a fit-for-purpose model with low model basis
  » What is an acceptable bias at individual station location?

» SR benchmarking against a uEMEP for all EU stations
  » **Compare bottom up analysis with uEMEP statistics**

» SR area can be reported as a shape in the e-Reporting

Absolute threshold values for Spatial Representativeness assessment

Legend: Rel 15% — Rel 15% + cutoff 3 — U(exp)-NO2 — U(exp)-O3 — U(exp)-PM10 — U(exp)-PM2.5