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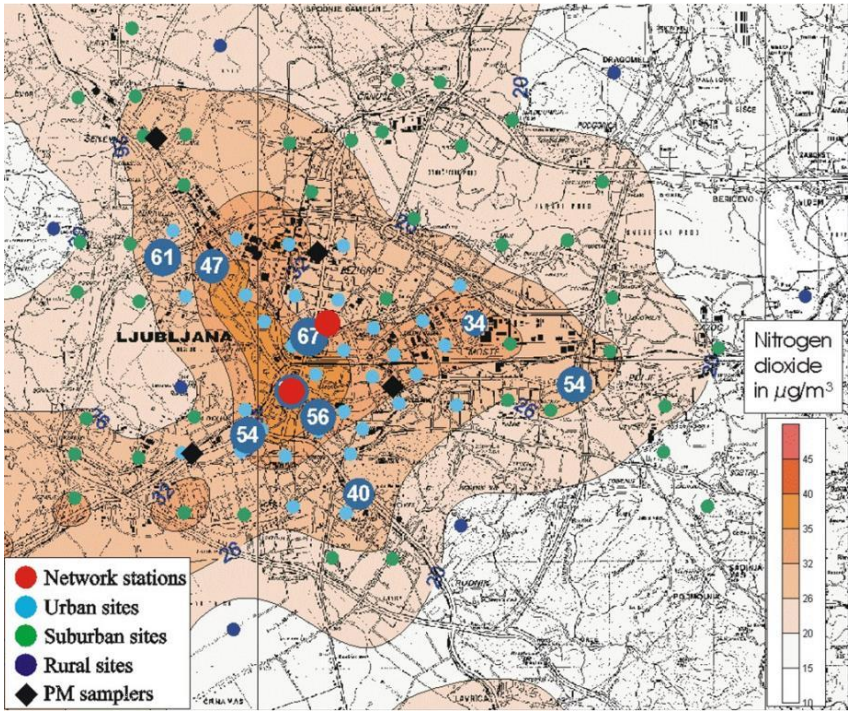
Cross-Cutting Activity on Spatial Representativeness

Interaction of Emission Information and Station Representativeness Studies



NO_2 annual average concentration levels in Ljubljana, from *Gerboles et al. (2007)*

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FAIRMODE Technical Meeting

28th and 29th April 2014
Kjeller - Norway

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Outline

1) Variety of aspects covered under the term spatial representativeness
2) Spatial representativeness methods based on a priori knowledge vs methods based on a posteriori information
3) Own research activities in this context (JRC)
4) Contributed slides (INERIS, VMM)

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Possible definitions of Spatial Representativeness

The variety of definitions does also reflect the variety of objectives covered under the term of spatial representativeness:

Different definitions can be required to suit different purposes:

- Model calibration and model validation
- Detection of spatio-temporal outliers
- Design of monitoring networks
- Exposure assessment
- Area of representativeness vs. simplified mathematical definitions
- Statistical evaluations
- Regulatory purposes and legislation
- …

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Spatial Representativeness

"Representativeness is the extent to which a set of measurements taken in a space-time domain reflects the actual conditions in the same or different spacetime domain taken on a scale appropriate for a specific application."

(Nappo et al. 1982)

"[the area of representativeness] … is the area in which the concentration does not differ from the concentration measured at the station by more than a specified amount."

(Larssen et al. 1999)

"A monitoring station is representative of a location if the characteristic of the differences between concentrations over a specified time period at the station and at the location is less than a certain threshold value."

(Spangl et al. 2007)

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A bit of taxonomy …

1) Spatial representativeness methods based on a priori knowledge
2) Spatial representativeness methods based on a posteriori information
3) Modelling based approaches (which often combine both)

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A bit of taxonomy …

1) Spatial representativeness methods based on a priori knowledge.
   - ➢ Evaluation of external parameters influencing air quality
2) Spatial representativeness methods based on a posteriori information.
   - ➢ Evaluation of observed air pollution concentrations (time series analysis, geostatistics, …)
3) Modelling based approaches (which often combine both).

1- Spatial representativeness methods based on a priori knowledge

External parameters influencing AQ

1. **Emissions** – on various spatial scales
2. **Dispersion** – triggered by meteorological parameters, which might in turn be influenced by topographic features
3. **Atmospheric chemistry** – triggered inter alia by meteorological parameters
4. …

(source: from UBA 2007)

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Contributed slides by Laure Malherbe (INERIS)

- Use of Metadata for Correlation Studies (Concentrations, Land cover …)

Contributed slides by David Roet (Flem. Env. Agency)

- A method for selecting monitoring stations for model validation in Flanders

  (considering emission data based on the UBA method)

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2 - Spatial representativeness methods based on a posteriori information

Own research activities:

1) Automatic screening tools for the recognition of anomalies in AQ monitoring data based on attribute values and spatio-temporal relationships *("Automatic Outlier Detection")*
2) Uncertainty of Measurement evaluated by geostatistical tools (using estimated nugget variances)
3) How can this support the evaluation of emission inventories

(for brevity – a short repetition of the Baveno slides; more detailed slides are available)

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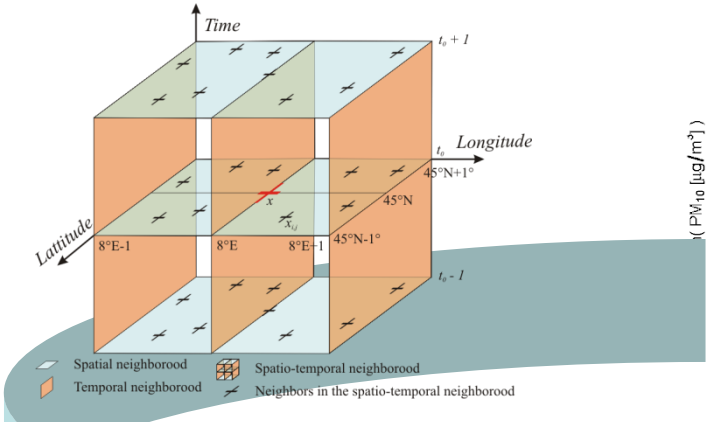
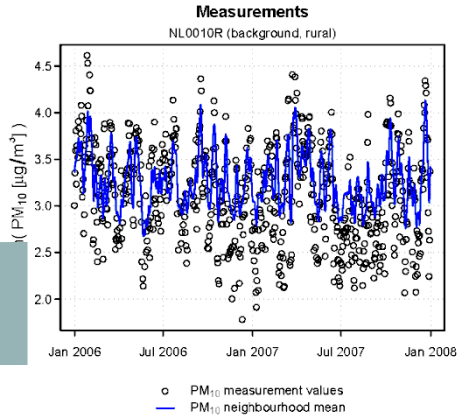
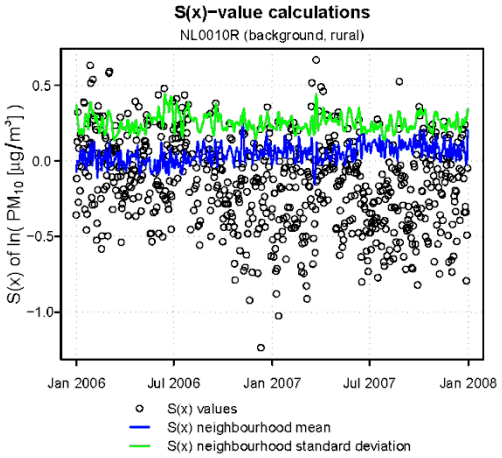
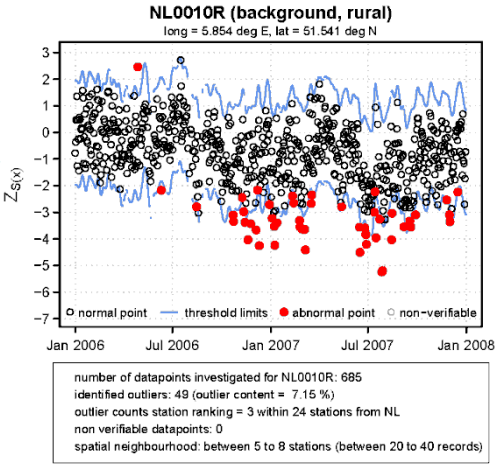
1st method: Automatic screening tools for the recognition of anomalies in AQ monitoring data









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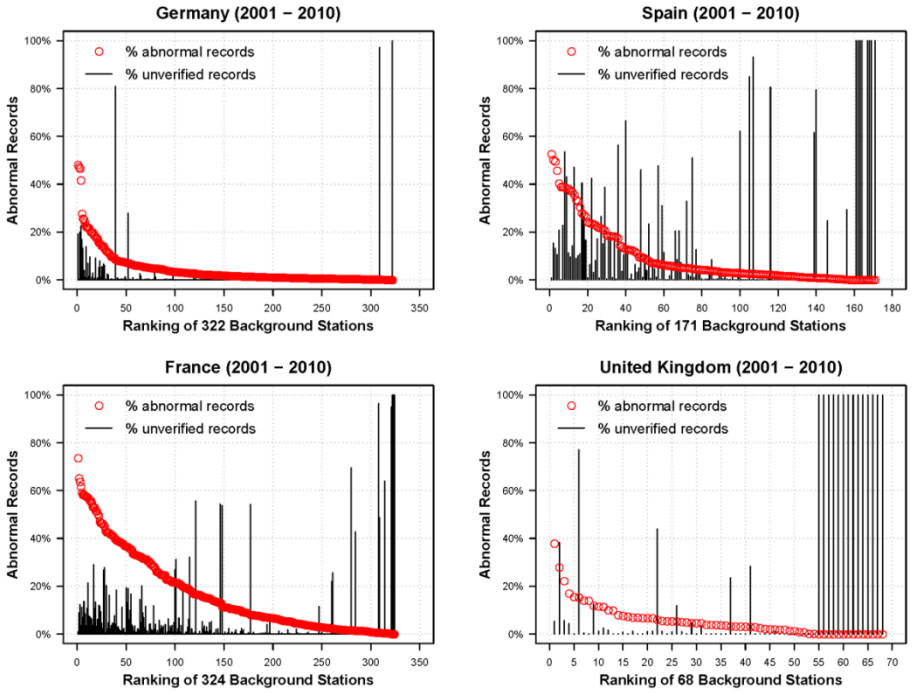
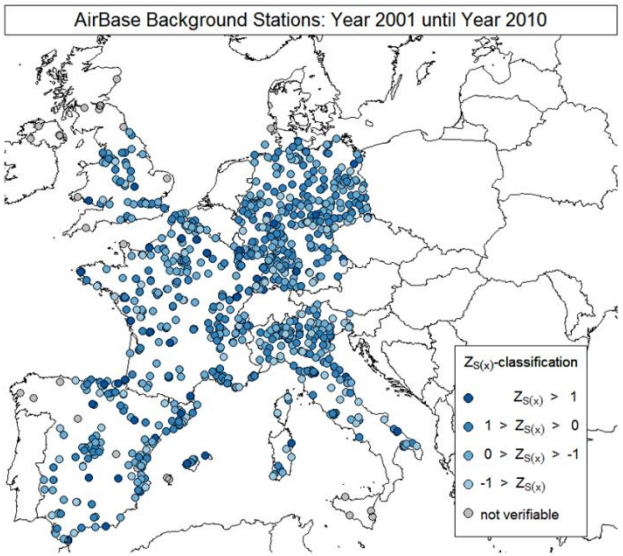
1st method: Automatic screening tools for the recognition of anomalies in AQ monitoring data

- Identification of spatio-temporal anomalies
- Indicators for evaluating the consistency of station classifications





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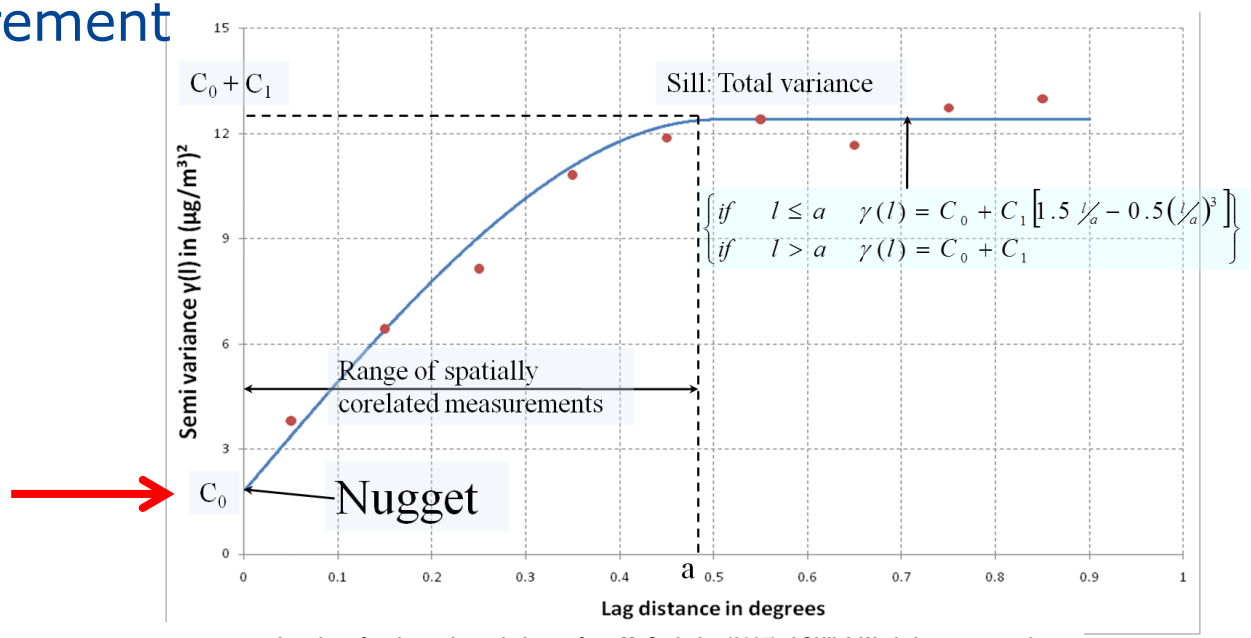
2nd method: Uncertainty of measurement evaluated from estimated nugget variance

- Comparison to the data quality objectives
- Identify trends over time in the nugget variance to investigate improvement (or worsening) of the uncertainty of measurement



source: explanation of variography techniques, from M. Gerboles (2007): AQUILA Workshop presentation

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The nugget variance is reflecting fluctuations of the measurements at very short distance (towards 0).

$$s^2_{nugget} = s^2_{meas} + s^2_{sc}$$

uncertainty of measurement
variance associated with the sampling and analytical variability

micro-scale variance
variability that occurs at distances lower than the shortest sampling distance (continuity).

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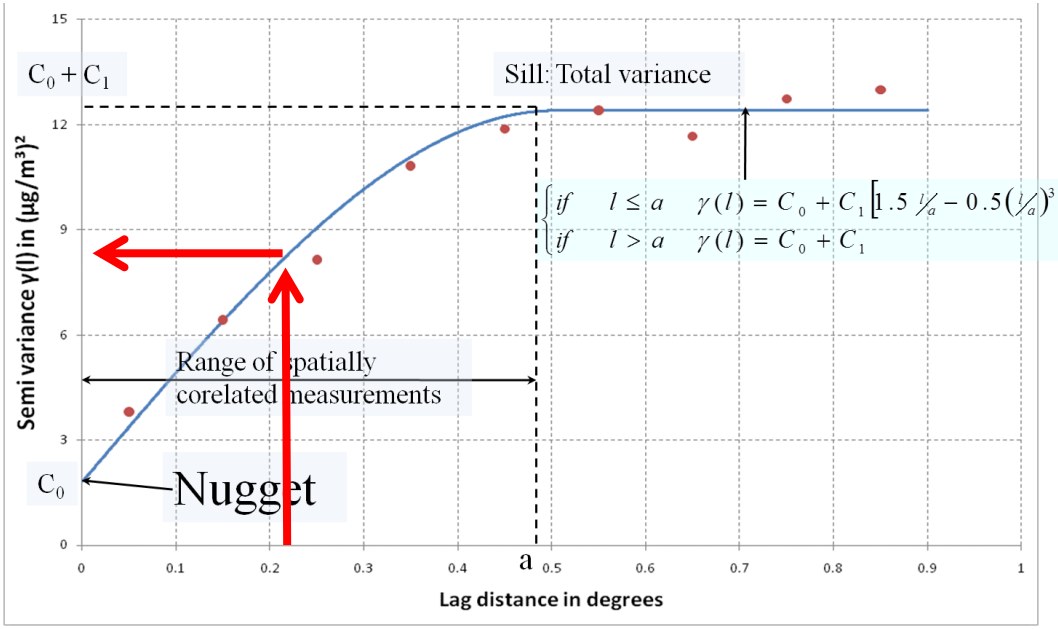
Information about WG 1 activities ….



source: explanation of variography techniques, from M. Gerboles (2007): AQUILA Workshop presentation

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WG 1: Possible consideration of spatial uncertainty in the MQO and in the MPC ?

- Variogram based description of spatial uncertainty
- Analogy to measurement uncertainty?

$$MQO = \frac{1}{2}\frac{RMSE}{RMS_U} = \frac{1}{2}\frac{\sqrt{\sum_{i=1}^{N} m_i - x_i^{\,2}}}{\sqrt{\sum_{i=1}^{N} U^{\,2}\ x_i}} \leq 1$$

(Thunis et. al, 2013)

- Caveat: distance based uncertainty measure introduces unfavourable dependencies of MQO from model configuration (grid spacing)
- Caveat 2: uncertainties in variogram parameter estimates can be large (note the different objective of our original approach)

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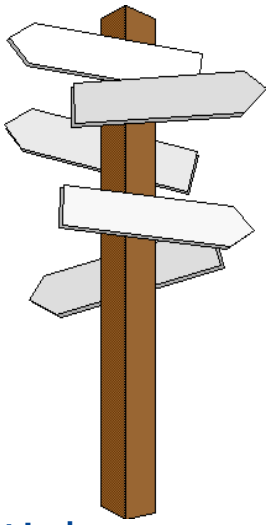

Key Questions to structure WG 2 discussion

CCA Spatial Representativeness:

Q1: User requirements of emission information for representativeness studies?

Q2: How can emission data administration profit from spatial representativeness investigations?

Q3: Prospective use of emission data beyond the estimation of the area of spatial representativeness (e.g., correlation studies presented by INERIS)?