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Uncertainty assessment in European air quality mapping and exposure studies

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The European topic centre for air pollution and climate change mitigation (ETC/ACM) has been developing mapping methods and operationally providing maps of European wide air quality for a number of years, as part of its tasks for the European Environment Agency (EEA). These maps are used to present the current state of air quality in Europe and to assess the population exposure throughout Europe and its Member States. To create these maps, monitoring data from the AirBase database is combined with other spatially resolved supplementary data (e.g. EMEP model outputs, altitude, population, meteorology) by first applying multiple linear regression to the supplementary data, to provide a spatial trend, and there after applying ordinary kriging to the residuals from this trend. Currently maps for PM10 and ozone indicators are operationally produced and more recently maps of PM2.5, using additional 'pseudo' PM2.5 observational data, have also been produced. These maps are provided at a resolution of 10 x 10 km2 and represent the ambient concentrations in rural and urban areas.

Exposure assessment using these maps is carried out assuming static population distributions. The exposure indicators calculated include population weighted concentration, used for long term health impact studies, and the population in exceedance of the European Air Quality Directive limit values, used for policy development. Exposure data is often aggregated to country level for policy applications.

An important aspect of the map making activity is the ability to assess the uncertainty of the concentrations, their likely sub-grid variability, and the propagation of this uncertainty and variability into exposure and eventual health estimates. Each step in the mapping process impacts on the uncertainty of the final exposure calculations. The steps and related uncertainty include:
• Monitoring data uncertainty including the creation of 'pseudo' monitoring data
• Uncertainty due to the spatial representativeness of the monitoring data
• Uncertainty in the multiple linear regression used to subtract the spatial trends before kriging
• Uncertainty in the kriging interpolation
• Uncertainty in the spatially distributed population data
• Uncertainty in the aggregation of concentration and exposure data

Currently the residual kriging variance is used to represent all the spatial uncertainty and this spatially correlated variance is also used to determine the aggregated population weighted concentration uncertainty. The population in exceedance of the limit values is currently only roughly estimated. This paper will present and describe the current methodology of uncertainty assessment and its limitations. We will suggest some possible improved methods for assessing the uncertainty and will be open for discussion concerning alternative and more appropriate methods.