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MEGAPOLI WP4: Megacity air quality

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The MEGAPOLI project brings together leading European research groups and state of the art scientific tools to investigate the interactions among megacities, air quality and climate. The main objectives of Work Package 4 (WP4) of the project included the realistic description of the main physical and chemical processes influencing the air quality in a megacity, with the use of relevant modelling tools. A major task of WP4 focused on activities investigating the multiscale physical and chemical processes that control pollutant transport, transformation and resulting concentrations from the city to the street scale, including a review and evaluation of current methodologies and the application of selected modelling tools in case studies. The aim of such approaches is to improve modelling skill in simulating small-scale features through the use of dynamical downscaling (usually in the form of model coupling), introduction of improved parameterisations for scale-specific processes and support for flexible nesting of computational grids. A metamodelling methodology was also refined for the implementation of an efficient two-way coupling between a mesoscale and a microscale CFD model for calculations over extended densely built urban areas. For the description of multiscale chemical processes, the PMCAMx chemical transport model (CTM) was used to simulate PM2.5 concentration and composition in the north-eastern United States.
A subsequent task of WP4 was to investigate the interactions between air quality, meteorology and climate parameters based on the analysis of air pollution episodes in selected megacities using a combination of measurements and model results. The effect of elevated pollutant concentrations on the meteorology as well as the influence of meteorological patterns on urban air pollution episodes was studied with the aid of an approach for categorising air pollution episodes according to the scale of the main source areas. By identifying the main contributing meteorological factors, episodes originating from local emissions were distinguished from those originating from regional and long-distance sources. The possible effects of elevated pollutant concentrations in and from megacities on the meteorology were studied and quantified, focusing on the investigation of indirect aerosol effects on meteorology using Enviro-HIRLAM model for the study period of summer 2005 in Paris and other Western European cities.
Source apportionment and the identification and quantification of relevant source contributions on the basis of combined modelling and monitoring results was the main focus of another task undertaken in the framework of WP4. Model applications were carried out, aiming to explore an integrated approach in source apportionment, involving innovative combinations of standard receptor modelling and state-of-the-art CTMs. A final task was the study of the main factors that influence the realistic estimation of human exposure to pollution levels in megacities, based on the use of appropriate modelling tools. A few examples of exposure models based on a mathematical modelling approach were used and evaluated, including a study of long term exposure at home residences for Greater London (United Kingdom) and Po Valley region (Italy), placing particular emphasis to the effect of spatial and temporal resolutions on exposure modelling. The sub-grid variability and its impact on both European-scale as well as city-scale exposure estimates was studied, revealing that significant errors in the population weighted concentrations can occur due to the use of finite grid sizes.