Megacities: Emissions, urban, regional and Global Atmospheric POLlution and climate effects, and Integrated tools for assessment and mitigation (EC FP7 Project MEGAPOLI)

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Abstract

An important concern for the emergence of increasing numbers of **megacities** is the high level of pollution within many of these cities, along with the **impacts** of the emissions from these urban agglomerations on downwind regions and **on regional and global climate**. The new European project **"MEGAPOLI" (Megacities: Emissions, urban, regional and Global Atmospheric POLlution and climate effects, and Integrated tools for assessment and mitigation)**, started in October 2008, brings together 27 research teams specializing in urban air quality and population exposure forecast and control, regional and global atmospheric pollution, and meteorological and climate research, including leading European research teams from 11 countries, along with state-of-the-art scientific tools, to investigate the interactions among megacities, air quality and climate. MEGAPOLI will bridge the spatial and temporal scales that connect local emissions, air quality and weather with global atmospheric chemistry and climate.

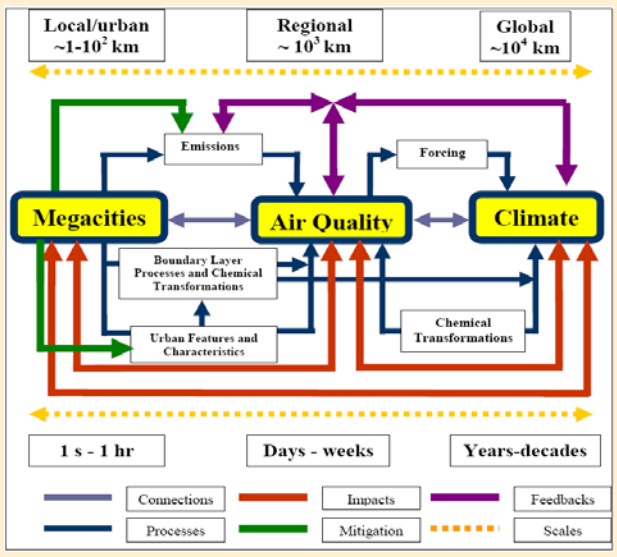
*The **main objectives** of MEGAPOLI are:*

1. to assess impacts of megacities and large air-pollution hot-spots on local, regional and global air quality;
2. **to quantify feedbacks among megacity air quality, local and regional climate, and global climate change**; and
3. to develop improved integrated tools for prediction of air pollution in megacities.

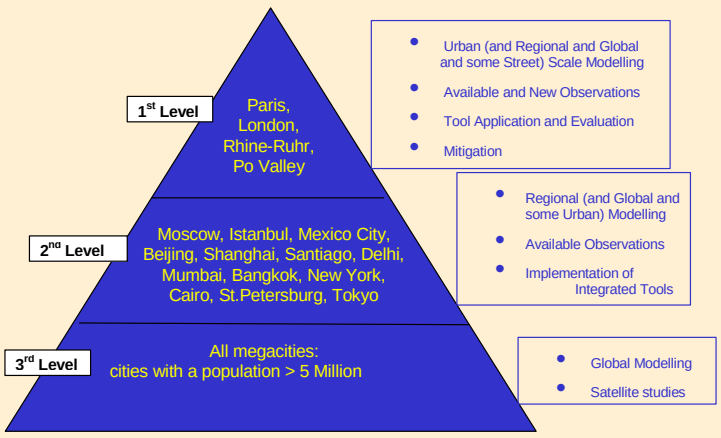
In order to achieve these objectives we follow a pyramid strategy of undertaking detailed measurements in one of the largest European megacities, Paris, performing detailed analysis for a limited set of megacities with existing air quality datasets, and investigating the effects of all megacities on climate and global atmospheric chemistry. Here we provide an introduction to the plans and approach within MEGAPOLI. Furthermore, we show results from three recently published studies on a worldwide comparison of megacity emissions, pollution levels and pollutant export, which will feed in as key initial results to the project.

Within the MEGAPOLI frame, an intensive **measurement campaign** will be conducted **in the Paris region** during summer 2009 and winter 2009/2010.

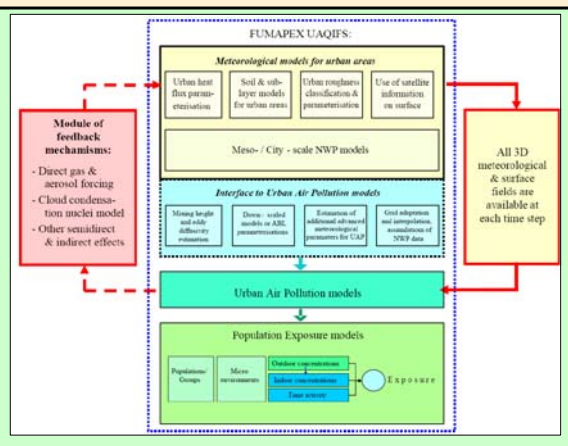
"Megacities" are coherent urban areas with a population of more than about 5 or 10 million people (there is no clear threshold or formal definition of a megacity at present). At present, there are about 30 with a population of 7 million or greater including about 20 cities worldwide with a population exceeding 10 million. The rate of growth of megacities has been tremendous; for example those with populations exceeding 10 million have grown from only 3 in 1975 to an anticipated 22 in 2015. The figure shows the city population trends for 1970-2015.

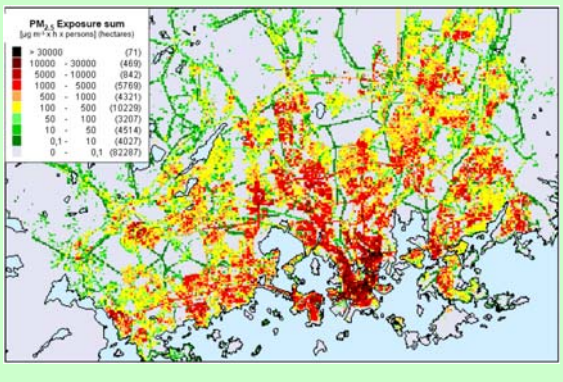


Schematics shows the ***main linkages between megacities, air quality and climate***. The connections and processes are the focus of MEGAPOLI. In addition to the overall connections between megacities, air quality and climate, it shows the main feedbacks, ecosystem, health and weather impact pathways, and mitigation routes which are studied in MEGAPOLI. The relevant temporal and spatial scales are additionally included.



The ***pyramid*** of megacities to be examined within ***MEGAPOLI***: The project will address practically all major megacities around the globe at three different levels of detailisation.

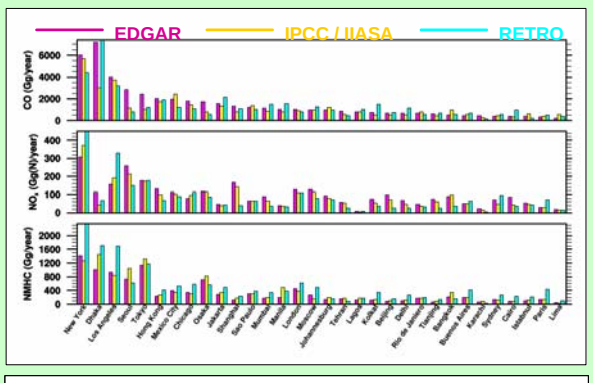


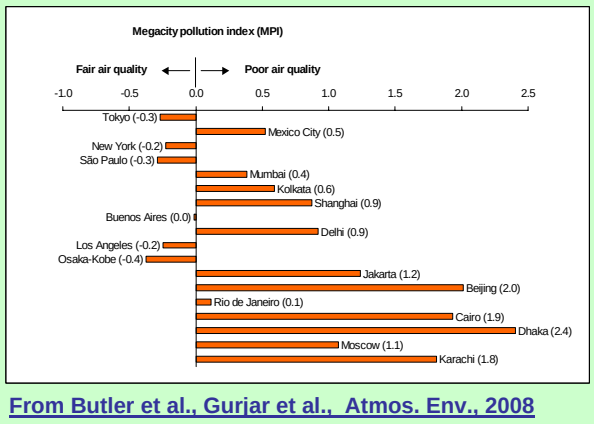


From Baklanov et al., Atmos. Chem. Phys., 2007, 2008

Top: On-line integration of urban climate/meteorology, atmospheric pollution and population exposure models for urban air quality information forecasting and information systems (UAQIFS).

Bottom: Population exposure to PM2.5, computed with the FMI EXPAND model, in the Helsinki metropolitan area for a peak pollution episode caused by stable atmospheric stratification combined with a strong ground-based temperature inversion.

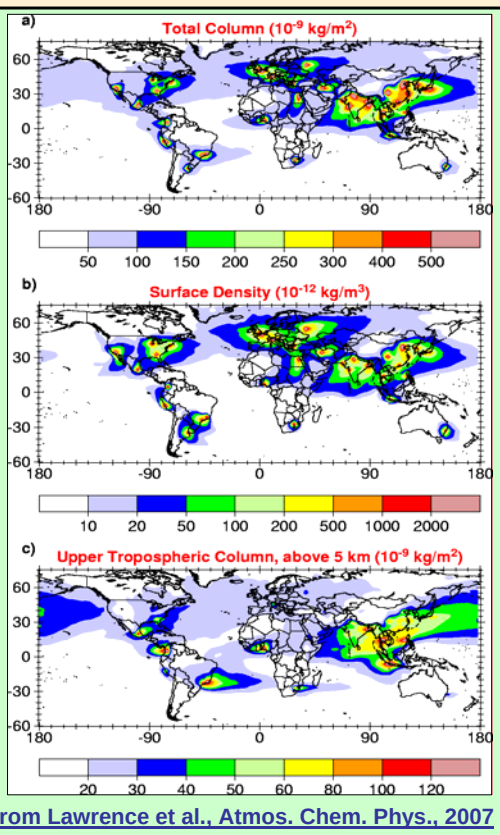




From Butler et al., Gurjar et al., Atmos. Env., 2008

Top: Comparison of the total emissions of CO, NOx and NMHCs from 32 of the largest cities in the world, based on the EDGAR, IPCC/IIASA, and RETRO databases.

Bottom: This study introduced a new way to characterize the overall pollution levels in various cities for comparison amongst each other, called the "Megacity Multi-Pollutant Index (MPI)", which is computed as: MPI = (1/n) [? (ACi - GCi) / GCi], where i = the pollutants included in the computation (here TSP, SO2, and NO2), n = the number of pollutants considered, ACi = ambient concentration (observed), and GCi = guideline concentration (WHO). The MPI is found to be inversely correlated with economic and education-level indices such as the knowledge intensity ratio (KIR).



From Lawrence et al., Atmos. Chem. Phys., 2007

Tracer simulation results (computed with the model MATCH-MPIC) to classify the regional pollution potentials of 36 selected megacities and major population centers worldwide. The tracers shown here are emitted at a constant rate of 1 kg/s from each megacity gridcell, and have an atmospheric exponential decay lifetime of τ = 10 days. The panels show the annual mean sum of all of the tracers for **(a)** the total column mass density (10^{-9} kg/m^2), **(b)** the model surface layer density (10^{-12} kg/m^3), and **(c)** the column above 5 km (10^{-9} kg/m^2). The figures exemplify some of the tradeoffs between local pollution buildup, long-range export to downwind surface regions, and transport to the upper troposphere.