Welcome to the 5th issue of the Newsletter

Editorial

The MEGAPOLI consortium is pleased to present the 5th issue of the MEGAPOLI Newsletter. Short contributions from Partners and Collaborators, as well as Research Teams introductions are given here. Details on the project progress can be found in public documents available at the project website (www.megapoli.info). The purpose of the newsletters is to inform about activities, progress, and achievements of the MEGAPOLI project as well as to establish a dynamic communication link with the Partners, Collaborators, and Users Community, to monitor the project activities and to exchange input and experiences. For these reasons your contributions to newsletters and news at the web-site as well as comments are always welcome (send to news.megapoli@dni.dk).

Latest News

- Coming soon – End-User Workshop "Mesoscale modelling for air pollution applications - achievements and challenges" (24-26 Feb 2010, Geneva, Switzerland) - organized together with WMO, GURME, COST-728 and MEGAPOLI in cooperation with CityZen, COST ES602, ACCENT, and MACC Projects - contact Liisa Jalkanen (LJalkanen@wmo.it)
- Coming soon – COP15 United Nations Climate Change Conference (7-18 Dec 2009, Copenhagen, Denmark)
- 2-4 Nov 2009 – International Workshop on Atmospheric Composition Changes: Climate-Chemistry Interactions (Lecce, Italy)
- 28 Sep – 2 Oct 2009 - MEGAPOLI relevant presentations at the AW11 Session "Environmental Meteorology (from local to global)" at the European Meteorological Society (EMS-2009) Annual Meeting (Toulouse, France)
- 24-25 Sep 2009 – 1st Annual Meeting of the MEGAPOLI Project (DMI, Copenhagen, Denmark)

MEGAPOLI 1st Annual Meeting (24-25 Sep 2009)

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20 MEGAPOLI Project Office Coming Presentations, Publications, Conferences

Danish Meteorological Institute (DMI)
The 1st Annual MEGAPOLI meeting attended in total - 65 persons
From 31 Research Institutions/ Organizations
From Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, The Netherlands, Norway, Russia, Spain, Switzerland, UK, USA.

During the meeting the presentations were given on
Day 1:
23 Oral + 1 Poster for MEGAPOLI WPs 1-9 & Megacities in Focus;
Day 2:
4 Oral – FP7 EC PBL-PMES and Russian partners of MEGAPOLIS.

Followed by discussions
WP3 – Paris Plume Study – Winter 2010 Campaign
- lead by Matthias Beekmann (CNRS)
WP8 – Mitigation, Policy Options, and Impact Assessment
- lead by Jochen Theloke (USTUTT)

and discussions in Thematic groups on different scale studies:
Local – lead by Alexander Bakanov (DMI)
Regional – lead by Spyros Pandis (FORTH)
Global – lead by Mark Lawrence (MPIC)
followed by summary presentations on thematic groups.

1st Annual MEGAPOLI Meeting
24-25 Sep 2009, Copenhagen, Denmark

24 Sep 2009
09.00–09.30 - Registration
09.30–09.40 - Welcome from the Host DMI
- Leif Laursen, DMI
09.40–10.00 - MEGAPOLI: General Outlook
- Alexander Bakanov, DMI

Progress for the MEGAPOLI Work Packages (WPs)

10.00–10.20 - WP1: Emissions
MEGAPOLI WP1 Emissions: Progress in year 1
- Hugo van der Gon, TNO
10.20–10.40 - WP2: Megacity Environments
Features, Processes, Effects: Status and Progress Report
- Igor Esau, NERSC
Paris Morphology Database, Preliminary Version
- Antti Hellsten, FMI

10.40–11.00 - Coffee Break

1st Results on Summer 2009 Paris Campaign

11.00–11.15 - WP3: Megacity Plume Case Study
MEGAPOLI Paris Campaign - Overview
- Matthias Beekmann, CNRS-LISA
11.15–11.25 - Meteorology Measurements During
MEGAPOLI Remote Sensing of Vertical Profile
- Martial Haefelin, CNRS-SIRTA/LMD/IPSL
11.25–11.35 - Airborne Measurements - First Overview
- Agnès Borbon, CNRS-LISA
11.35–11.45 – MoLa: Measurements During MEGAPOLI
2009 Paris Intensive Campaign
- Mark Lawrence, MPIC
11.45–11.55 - Ground Based Gas Phase Measurements
- Valérie Gros, CNRS-LSCE
11.55–12.10 - Aerosol Measurements at Ground Stations
- Jean Sciare, CNRS-LSCE
12.10–12.20 - Mobile Measurements: Preliminary Examples
- André Prevot, PSI
12.20–12.30 - Combined Use of car MAX-DOAS and Satellite Data for Estimation of Megacity Emissions
- Mark Lawrence, MPIC
12.30–13.40 – Lunch

13.40–14.00 - WP4: Megacity Air Quality
- John Douros, AUTH
14.00–14.20 - WP5: Reg & Global Atmospheric Composition
- Regional – Jaakko Kukkonen, FMI
- Global – Andreas Stohl, NILU
14.20–14.40 - WP6: Regional and Global Climate Effects
- Regional – Filippo Giorgi, ICTP
- Global – Bill Collins, UK MetO
14.40–15.00 - WP7: Integrated Tools and Implementation
- Ranjeet Sokhi, UH-CAIR
- Jochen Theloke, USTUTT
15.20–15.40 - Coffee Break

15.40–16.00 - WP9: Dissemination and Coordination
- Alexander Bakanov, DMI
16.00–16.50 - Overview of Megacities in Focus
Paris and the Ile-de-France Region
- Veronique Ghersi, AIRPARIF
Po Valley: Emission Inventory and Preliminary Analysis of Pollutant Export
- Sandro Finardi and Paola Radice, ARIANET
London Case Study Preparations
- Ranjeet Sokhi, UH-CAIR
The Rhine–Ruhr Region
- Melinda Uzbasich. USTUTT
**1st MEGAPOLI Annual Meeting**  
**24-25 Sep 2009, Copenhagen, Denmark**

**24 Sep 2009 (continued)**

16.50–17.00 - Break
17.00–17.45 – Discussions:
  WP3: Paris Plume Study Winter 2010 Paris Campaign Discussions  
  (lead by Matthias Beekmann, CNRS)
  WP8: Mitigation, Policy Options and Impact Assessment  
  (lead by Jochen Theloke, USTUTT)
17.45–18.15 - MEGAPOLI Steering Group Meeting  
  (lead by Alexander Baklanov, DMI)
19.00 – Dinner

**25 Sep 2009**

09.00–10.30 – Discussions:
  Thematic Groups on Different Scale Studies
  – Global, HIRLAM Meeting room  
    (lead by Mark Lawrence, MPIC)
  – Regional, Auditorium Meeting room  
    (lead by Spyros Pandis, FORTH)
  – Local, Drivhuset Meeting room  
    (lead by Alexander Baklanov, DMI)
10.30–10.50 - Coffee Break
10.50–11.20 - Discussions in Thematic Groups on Different Scale Studies (continued)
11.30–12.20 - Summary presentations from each group and linkage between groups
12.20–12.30 - Collaborative FP7 EC Project PBL-PMES  
  – Sergey Zilitinkevich, FMI
12.30–13.30 – Lunch
13.30–14.00 – MEGAPOLIS Russian Project, General Info  
  – Valery Bondur, AEROCOSMOS
  – Nikolay Kasimov & Galina Surkova, MSU
  – Georgy Golitsyn, IFRAN RAS
14.00–14.30 - Discussions/ linkage with tasks and activities of the MEGAPOLI (MEGAPOLIS and other projects)
14.30–15.00 - Items/ topics of the 1st year MEGAPOLI reporting  
  (deliverables, milestones, dissemination, management reporting)
  – Alexander Mahura, DMI
15.00–15.30 - Discussions of plans for the 2nd year  
  – Alexander Baklanov, DMI
15.30–15.50 - Coffee Break
15.50–16.30 - Discussions of plans for the 2nd year (continued)
16.30–17.00 - Summary of the 1st MEGAPOLI meeting
17.00 - Adjourn
18.00 – Signing joint memorandum on collaboration between the FP7 EC MEGAPOLI and Russian MEGAPOLIS projects in the Russian Cultural Center (Copenhagen)
**Abstract**

The contribution to climate change from the emissions of long-lived greenhouse gases (carbon dioxide, methane and nitrous oxide) from Megacities is given as Deliverable 6.1 of the MEGAPOLI Project. Megacities are found to contribute around 10% of the anthropogenic emissions of these gases. The climate impacts are calculated in terms of surface temperature change using a simple analytical climate model. For an emission pulse, the long-term temperature is driven by solely by CO₂ for a step change in emissions methane and nitrous oxide contribute about 12% of the temperature change.

**Emissions**

To determine the climate impact of greenhouse gas emission from megacities we took the emissions of carbon dioxide, methane and nitrous oxide from the EDGAR v4.0 database at 1 degree resolution. These 3 gases were chosen as they are the most important for climate forcing. We neglected halo-carbons as individually they make only a small contribution even though in total their magnitude is significant. The carbon dioxide emissions are shown in Fig. 1. Note that the emissions are very localised.

To identify the megacity emissions we applied the megacity mask from Butler et al. (2009) adding in areas corresponding to the Ruhr and Po valleys (taken from WP1). The results are shown in Fig. 2. Megacity emissions comprise 12% of global anthropogenic CO₂ emissions, 7% of the methane and 4% of the nitrous oxide. This is because the CO₂ emissions are more localised than the other two species.

**Acknowledgements**

The megacity mask was provided by Tim Butler, Max Planck Institute for Chemistry, Mainz, Germany

**References**


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**Climate Impacts**

To determine the climate impact of the 3 gases we used the method of Boucher and Reddy (2008) to calculate the surface temperature change. This method uses a simple analytical model to relate radiative forcing to temperature, and to describe the carbon cycle.

We conducted two experiments, in both cases starting from conditions with no megacities. In the first case megacity emissions were turned on for a 1 year pulse and then switched off. In the second case megacity emissions were turned on, and left on as a step change. The results of these are shown in Fig. 3.

For the pulse emissions, the methane concentrations grow very rapidly, but then decay with an ~12 year e-folding time, whereas the carbon dioxide and nitrous oxide concentrations maintain their levels. For the first 5 years after the pulse about half the temperature rise is due to the methane emissions. After 60 years the methane contribution is negligible.

For the step change in emissions the methane concentrations plateau whereas the carbon dioxide and nitrous oxide concentrations continue to rise. The increase in surface temperature after 100 years of megacity emissions is 225 mK, of which 200 mK is due to the CO₂ emission, 22 mK due to the methane emissions and 3mK due to the nitrous oxide emissions.

**Conclusions**

Megacities account for 12% of the anthropogenic CO₂ emissions and lesser fractions of the methane and nitrous oxide emissions. Even maintaining a constant 2005 level of emissions, megacities will be responsible for a 225 mK warming over the next 100 years. Just under 90% of this warming is due to the CO₂. Methane emissions have a larger impact in the short term.
Regional Climate-Chemistry (RegCM-CHEM) Coupling: 1st Year Preliminary Results

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ICTP-RegCM Model (RegCM-CHEM) Developing

Chemistry plays an important role in determining current and predictions of the future state of earth’s climate, because a large number of agents that force earth’s climate are chemically active. Chemical processes in the atmosphere determine the abundances and properties of atmospheric forcing agents. From an atmospheric chemistry perspective, changes in the atmospheric composition, which force the climate system, are of primary interest. It is precisely the composition changes—natural or anthropogenic—that also forces the climate system to change, above and beyond the forcing by other natural factors such as the Earth’s orbit, solar activity, etc. In some sense, other long-term changes such as those in ocean circulation can be treated as “natural” variations that are beyond human control.

The ICTP contribution is mostly linked with model development, and the following steps have been accomplished so far: 1) Determined a regional model domain to develop climate-chemistry feedback over European mega cities; 2) Developed an emission pre-processor for RegCM-CHEM which takes into accounts all of the available global emission inventories. 3) Coupled an online biogenic VOC emission module (MAGEN) to the land surface model of RegCM-CHEM, enabling an interactive treatment of natural emissions and climate; 4) coupled a suite of gas phase chemical mechanisms to RegCM-CHEM and evaluated the model during the heat-wave over Europe. Based on the comparisons with an observational network of ozone data from EMEP, the results indicate that the gas-phase schemes accurately simulate ozone, an important greenhouse gas.

![Image: Technical schematic of chemical processes coupled in RegCM-CHEM](http://www.ictp.trieste.it)

**Figure 1.** Technical schematic of chemical processes coupled in RegCM-CHEM

**Gas-Phase Mechanisms and Organic species lumping techniques in RegCM-CHEM**

Most inorganic (inorganic photolysis and inorganic oxidation reactions) use approximately the same representation in all mechanisms. However, due to extremely large number of organic chemical species in the atmosphere, there are several approaches used in chemical mechanisms to describe wide range of organic compounds. There are 2 major approaches to deal with hundreds of organic species: *(a) Lumped molecule (RADM2, RACM, GEOS, GEOS_SILL) – (b) Does not conserve carbon mass; and Lumped structure (CBM-IV, CBM-Z) – (a) Surrogate species base on carbon bonds single bond species, double bond species; (b) Relatively fewer categories are needed to represent organic species; c) Conserve carbon mass.*

**Chemical Solvers: The Kinetic Pre-Processor (KPP)**

Current atmospheric chemistry mechanisms include hundreds of reactions and dozens of chemical species. For example, the condensed chemistry mechanism developed by Collaborator Sanford Sillman (from Michigan University, USA) (GEOS_SILL) has 533 reactions and 157 species. In order to derive solutions to these chemical reactions, this would require solving corresponding large systems of ODE, requiring highly efficient numerical integrators and costly code developments and updates. Automatic Code generation has become widely used tool to approach above problems, and one such generation is the Kinetic Pre-Processor (KPP; Sander and Sander, 2006). The KPP solver needs only three files (user defined), including one for the set of mechanism equations, one for definitions of species and the last one for initialization and inline code. The KPP will process such files and produce a complete package for simulation of such mechanisms. KPP used to produces the chemical mechanisms for the gas-phase (RADM2, CBM-Z, and RACM).

**Coupled Chemical Mechanism and Chemical Solver Options**

In RegCM-CHEM, we plan to have several chemical mechanisms coupled to the climate model, so that the user can select the appropriate chemical mechanism for their application. To date, we have tested several chemical mechanisms and several chemical solvers within RegCM-CHEM. These include the following: *(a) Updated GEOS-CHEM (SILL), using Sanford Sillman box model code; and (b) Updated GEOS-CHEM (GEOS_KPP), (c) CBMZ (CBMZ_KPP), and (d) RACM (RACM_KPP) using KPP to produce the code.*

**Case Study of Heat-wave over Europe, 2003**

In August 2003, Europe has been suffered from a heat wave lasted 15 days; this heat wave was accompanied by a high level of ozone. We chose this period as a case study to evaluate the coupled climate-gas phase chemistry model. We used EMEP stations (Fig. 2) network for ozone to validate the outputs. EMEP (European Monitoring and Evaluation Programme) is a scientifically based and policy driven programme under the convention on Long-range Transboundary Air Pollution for international co-operation to solve transboundary air pollution problems (http://www.emep.int).

- Three gas-phase mechanisms are coupled on-line with RegCM-CHEM (updated GEOS-CHEM, KPP_GEOS-CHEM, KPP_CBMZ and KPP_RACM), each of them include different solver.
- Global emission inventories from RETRO, POET, EDGAR, and GFED are re-gridded and interpolated to the model grid spacing (60 km) using bi-linear interpolation.
- The numbers of transported species are 19; number deposited (dry) - 14 out of 19 using a new gas-dry deposition scheme which is on-line coupled with RegCM-CHEM recently.
- RegCM-CHEM is validated using EMEP ozone measurement during the heat wave over Europe (1-15) August 2003.
- The result shows that the model captures the same feature of the observed ozone spatial and temporal distribution over the studied domain as shown in Fig. 2. The modelled maximum of ozone concentration shows underestimation, which may be due to the lack of some ozone precursor sources.
Evaluation of Zooming Approaches Describing Multiscale Physical Processes

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The treatment of physical effects across multiple spatial scales has been one of the long-standing issues in numerical weather prediction (NWP) and climate modelling. As part of the MEGAPOLI WP4 activities, zooming approaches are being evaluated for simulating the effect of local forcings in regions of strongly structured topography and within the urban canopy. Zooming approaches, in a variety of implementations, are increasingly applied as part of a strategy for establishing consistent numerical treatment of multiscale dynamical effects, while maintaining a small computational resource footprint. In essence, the aim of such approaches is to improve the parent model’s skill in simulating small-scale features through the use of dynamical downscaling (usually in the form of model coupling), introduction of multiple parameterisations for scale-specific processes and support for flexible nesting of computational grids. At the same time, the WP4 collaborating teams have been seeking out ways to minimize uncertainties and cope with the main sources of error arising in modelling of cross-scale interactions.

In a typical implementation of dynamical coupling, the smaller scale model is driven by introducing parameter fields, extracted from larger-scale calculations in specified intervals, as boundary conditions. Major design issues for any zooming methodology involving dynamical downscaling, particular in the urban-to-street scales, include:

- the treatment of incompatible physical parameterisations across different scales
- modelling errors inherent to the various scale-specific parameterisations
- minimisation of spatial discretisation errors, a particularly problematic source of uncertainties due to the fact that characteristic scales of various processes, and therefore the grid resolutions required to resolve them, often need to be determined by numerical experiment.

Current modelling strategies attack these problems by incorporating multiple alternative approaches, either used in a complementary fashion or provided to the model user in a modular form as selectable options.

The European Zooming Model (EZM) (Moussiopoulos, 1994) is a comprehensive model system developed for simulating wind flow and pollutant transport and transformation in subregions of the European region. It is one of the most widely tested and verified European air pollution models and is especially suited for urban air quality studies. EZM evolved to be a stand-alone model system which may be driven with measurement data. Recent enhancements to EZM provide a mechanism for enabling two-way interaction of the mesoscale model with a local-to-microscale model simulation of urban flows in- and over built-up areas, as well as the estimation of feedback effects on the mesoscale induced by the presence of the urban-scale structure (Tsgeas et al., 2009). A preliminary validation of the system for an urban test case in Athens, Greece has indicated a significant reduction of the low-level wind speeds compared to the reference mesoscale calculation. The presence of the urban structures induces a distinctive modification of the vertical turbulent kinetic energy profile, extending to a height of up to 2.5 times the average roof height.

An integrated set of meteorological model forms the foundation of the Enviro-HIRLAM integrated system (High Resolution Limited Area Model, Baklanov et al, 2009) aimed at coupled meteorological and chemical transport simulations on the regional to urban scales. In order to cope with the heterogeneity of parameterisations across scales, a multi-approach strategy is implemented, combining the use of field downscaling, modification of the mesoscale parameterisations over urban areas and explicit modelling of the urban sublayer. In the latter case, an increased vertical resolution in the NWP model becomes necessary for an accurate estimation of the urban surface energy budget. Numerical evaluations of the integrated model indicate a significant reduction of average wind speeds up to 2.5 m/s in the urbanized case, while the combined thermal effects in the urban canopy typically induce a temperature increment of up to 2 °C, particularly pronounced during the late evening and night hours.

In the oncoming months, WP4 groups will seek to finalise a concrete performance assessment of the proposed zooming approaches, while ideas and suggestions are continuously being tested and challenged through application in urban test cases. We expect that the ongoing work on validation cases involving the “1st level” MEGAPOLI regions will provide significant benefits on the improvement of methodologies, as well as the necessary calibration of existing parameterizations.

References


Influence of Paris on Regional Thermal Structure

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One of the main objectives of MEGAPOLI is to investigate the influence of Megacities on regional air quality. A Megacity is characterized by large emissions of primary and secondary pollutants such as NO_x, O_3, organic compounds as well as particles. However, the direct influence of the emissions is not the only way the city affects air quality. In particular, the interaction between soluble particles and clouds may be of importance. Particles may be transported downwind in the urban plume into cloudy environments where they activate and contribute to an increase in cloud droplet number concentration. Such an increase leads to enhanced cloud-top reflectance through the first aerosol indirect effect (Twomey, 1974) and modification of precipitation development through the second aerosol indirect effect (Albrecht, 1989). This is of importance to air quality because cloud cover (actinic fluxes) and temperature may change downwind and thereby influence photochemistry and chemical reaction rates. Additionally, such changes may lead to dynamical redistributions of the chemical species due to local thermally induced circulation cells, changes in wind and boundary layer structure. In this study we investigate the effect of particle emissions in the greater Paris area on the regional thermal structure. Model simulations with and without the first and second aerosol indirect effects in a single meteorological case were compared to two-meter temperature measurements (T_2m).

The meteorological setting was governed by deep convection and rain in the days prior to the forecast period. During runtime (covering June 30 to July 1 2005) the domain was governed by cloudiness and convectively unstable air, with westerly winds and small amounts of rain. Such a setting has been chosen to optimise the second aerosol indirect effect. The investigation comprised four model runs under identical settings except for the inclusion of the first aerosol indirect effect (1IE), the second aerosol indirect effect (2IE), both effects (12IE) and neither effects (REF).

In general, inclusion of the indirect effects led to decreased temperature during daytime and slightly increased temperature during night time at stations where cloud cover changed (Fig. 1). At individual points the temperature change may be up 5°C. From run 2IE it was found that the second indirect aerosol effect led to increased cloud cover through suppression of auto-conversion. The 1IE run showed that the first indirect effect had only negligible influence in this meteorological case. Large influence of the first indirect effect is only expected for thin cloud layers. Comparing to measurements of T_2m (using 31 standard WMO stations evenly distributed in the modelling domain with three hourly updates) shows that run 12IE performs better than REF during late afternoon and early evening on most stations (Fig 2.).

The results present a consistent physical picture where the presence of anthropogenic sulphate aerosols increase cloud droplet loading leading to increased cloud lifetime and corresponding changes in temperature. The fact that comparison with two meter temperature improves when including the effects lends credibility to the results. However, a sensitivity study to determine whether the model atmosphere was in a particular nonlinear regime has not been conducted. This will be included in further experiments with larger temporal coverage, during the MEGAPOLI project.

Acknowledgements
Allan Gross is acknowledged for the development of the chemical scheme used in the experiments while at DMI.

References
Urbanization Related Studies in India: An Overview

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Due to rapid urbanization and industrialization in India, several Indian researchers are focusing their works on the urban related studies. A few of them are briefly described hereinafter.

Max Planck Partner Group for Megacities & Global Change

In South Asia one third of the 15 largest megacities are found, with a combined population of about 70 million, which is more than combined population of several small countries of Europe. Three of the largest and most rapidly growing of these megacities are in India (Delhi, Kolkata and Mumbai). The economy in the Indian subcontinent is growing rapidly, and megacities are playing crucial roles as their relatively better infrastructure and skilled workers attract international businesses and investments, which enhance the overall employment capacity of these cities. The Improving employment opportunities attract the rural population to migrate into the cities. Because of the growing industrial activities and energy use, the burgeoning megacities are growing into huge conglomerates of air pollution sources with local and global consequences for air quality and climate. The Max Planck Partner Group for Megacities & Global Change (http://www.iitr.ernet.in/outreach/web/mppgroup/), which is a joint research group of MPIC Mainz (Germany) and IIT Roorkee (India) with financial support from the Max Planck Society (Germany), is conducting local-to-regional-to-global air quality studies. A few of them are briefly described hereinafter.

Regional atmospheric environment and intercontinental transport of pollutants

A three-year (2008-2010) project by Indian and Italian scientists, which is being carried out at Indian Institute of Tropical Meteorology (IITM), will help determine the amount of air pollutants that are being transported to India from different parts of the world and vice-versa. The major contributors to the deterioration of air quality are pollution from vehicles and the burning of fossil fuels. The project has been selected in the framework of the Indo-Italian programme of scientific and technological co-operation for by the Department of Science and Technology (DST). IITM is the only institute in Asia which has the mandate for tropical meteorology research. More details are available at: http://timesofindia.indiatimes.com/home/environment/pollution/Now-a-project-to-nail-global-air-polluters/articleshow/4253648.cms

Urban study related projects at IIT Delhi

There are several research projects (http://www.iitd.ac.in/~tripr/RRframe.html) being carried out at IIT Delhi which focus on sustainable transport systems in Indian cities.

Urban Air Pollution Control

Research undertaken by Central Pollution Control Board (CPCB) indicates that tentacles of vehicular pollution have also extended to small cities and towns. The CPCB is reviewing action plans of seven cities cities out of the sixteen cities namely Agra, Varanasi, Patna, Jodhpur, Faridabad & Pune identified by the Hon’ble Supreme Court of India, while other seven cities namely Lucknow, Kanpur, Sholapur, Hyderabad, Chennai, Bangalore, Ahmedabad are reviewed by EPCA while the action plans in two cities i.e. Kolkata and Mumbai are reviewed by the respective (High Courts).

Inventory of Evaporative Emissions of Hydrocarbons from various sources in Delhi, Kolkata, Mumbai and Chennai

This study was executed by NEERI Zonal Laboratory, Mumbai. The study has been completed and report is being published.

Monitoring and inventory of Volatile Organic Compounds (VOC) in Urban Air of Delhi & Mumbai

This study was executed by National Environmental Engineering Research Institute (NEERI) Zonal Laboratory, Mumbai. The study has been completed and the report is being published.

Estimation of Emission Load from Vehicular Sources under Various Scenarios

The exercise involves calculation of vehicular emission load in major cities using various scenarios like completely/partially switching over to cleaner alternate fuels, leapfrogging emission norms for new vehicles etc.

Ambient Air Quality Status of Kolkata with reference to Ozone and VOCs

The study is being executed by NEERI Zonal Office, Kolkata. The objective of the study is to provide background information to research workers, policy makers and other stakeholders on the following areas: Ambient levels of NOx, carbonyls, ozone and speciated VOCs. These levels are characteristics of source emission impacts.

Nation-Wide Assessment of Vehicular Pollution Control Measures

The vehicular pollution control has been emphasized in megacities until recently. However, in the recent few years the tentacles of vehicular pollution have also extended to small cities and towns. Thus, the requirement to look upon the problems of vehicular pollution at local level has been visualized to curb this menace throughout the country. The CPCB is attempting to assess the status of vehicular pollution in terms of problems, steps taken and required to be taken in various cities/towns of the country before the vehicular pollution becomes a major problem there.

Assessment of Aldehydes, Ketones and Methane emissions in Vehicle exhaust, using different fuels (Petrol, Diesel, LPG, CNG, Ethanol in Petrol, Biodiesel and Hythane)

This study is being undertaken by CPCB in association with ICAT, Manesar with the objective to characterize Aldehydes, Ketones and Methane emissions in vehicle exhaust of 2-wheelers, 3-wheelers, 4-wheeled passenger vehicles, 4-wheeled light duty commercial vehicles & 4-wheeled heavy duty commercial vehicle engines operating on different fuels i.e. Petrol, Diesel, LPG, CNG, Ethanol (5%) in Petrol (BS III) and Biodiesel (10%) in Diesel (BS III) & Hythane.

Evaluation of Performance and Durability of Catalytic Converters and Development of Short Test Procedure for checking Performance of such Converters fitted on in-use vehicles

The study is proposed to be undertaken by CPCB in association with suitable executing agency with following objectives and terms of references. Evaluation of long term performance & durability of catalytic converters in on-road vehicles Development of short test procedure for checking performance of catalytic converters in on-road vehicles Improvement in existing PUC procedure to have better co-relation with standards mass emission system.

Comparative risk assessment for interventions aimed at reduction of Indoor air pollution associated with biomass fuel use in rural and urban settings of Andhra Pradesh, India - An integrated evaluation based on health risks and greenhouse gas emissions

The objectives of this study include: Assess emission and exposure potentials for pollutants associated with combustion of solid fuels in rural Andhra Pradesh; Develop integrated environmental strategies to address indoor air pollution associated with combustion of biomass fuels through the assessment of co-benefits of reduction of emission of health damaging pollutant as well as green house gas emissions; Evaluate cost-effectiveness of possible interventions based on co-benefits.

http://www.srmc-ehe.org.in/3_Ongoing_projects.php
Is a Kuznets Paradox on the Horizon for Developing Megacities?

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International Energy Agency
– Currently on secondment from the U.S. Environmental Protection Agency

This work was prepared independently and does not necessarily reflect the views of the IEA or US EPA.

The United Nations estimates that since 2008, and for the first time in human history, a majority of the world’s population is now living in urban areas. This long-term demographic shift shows no signs of abating, and holds profound implications for environmental and energy policymakers at all levels of government.

Broadly speaking, where you have more people, you will often find more pollution. A lack of access to affordable clean-energy technologies or effective emission controls often leads to even higher concentrations of health-damaging pollutants such as particulate matter in developing urban areas. Basic activities for human survival such as cooking and heating are often enabled out of sheer necessity only by means such as open burning of fossil fuels, biomass (e.g., wood, straw), and even highly toxic materials such as tires.

Figure 1 uses coarse particular matter (PM$_{10}$) to illustrate the disparities in air quality levels between OECD and Non-OECD megacities. The chart shows nearly twice as many people living in the Non-OECD megacities, roughly in line with the relative number of cities for which data were analyzed. What is more alarming is the disparity in PM$_{10}$ levels between OECD and Non-OECD. The population-weighted average for Non-OECD cities is approximately 90 micrograms-per-meter-cubed, almost three times higher than that of OECD megacities, and more than four times the limit recommended by the World Health Organization.

Figure 1. The health burdens of PM$_{10}$ air pollution lie heavily in the large urban areas of developing countries.

The high PM$_{10}$ levels in Non-OECD megacities paint a grim picture, but are not particularly surprising if one believes there is some truth to the Environmental Kuznets Curve. As shown in Figure 2, the curve predicts that in the early growth stages of economic development, environmental degradation increases up to a point, after which it reverses course once a certain standard of living is achieved and social priorities shift (blue solid line). Developing urban centres can be thought of as falling somewhere along the upper end of the left-hand side of the curve, looking to make it over the turning point and begin moving along a downward slope that represents continued economic growth paired with improving environmental conditions.

However, even with significant reductions in traditional non-greenhouse-gas pollution, it is possible that environmental gains may be offset if severe climate change scenarios are realized (red dashed line). The actual outcomes would vary by city, and depend on a complex array of spacial and temporal variables, but significant negative impacts would be expected in most locations around the world.

The prospect of severe climate change presents a unique two-fold dilemma for developing urban areas. Firstly, the vast majority of greenhouse gases (GHGs) already in the atmosphere were emitted by developed countries, which are likely to remain relatively high-volume GHG emitters for some time. In other words, even if developing megacities control what they can (localized air pollution), they may still be negatively impacted by an environmental phenomenon that cannot be fully controlled on a local or even national level (rising atmospheric GHG concentrations).

Secondly, developing megacities will remain much less well equipped than their developed counterparts to deal with climate change impacts for the foreseeable future. Adaptation may necessitate shifting limited resources away from the control of traditional pollutants, and in a sense sliding backwards along the Kuznets curve.

The MEGAPOLI project aims to assess climate change and air quality issues in megacities, with the ultimate goal of informing smarter and more integrated policies in the future. As MEGAPOLI moves its focus beyond E.U. cities to emerging urban areas such as Cairo and Moscow, unique considerations such as a Kuznets paradox may be useful in shaping project-related policy objectives.

References

Pandey et al., 2006: Ambient Particulate Matter Concentration in Residential and Pollution Hotspot Areas of World Cities: New Estimates Based on the Global Model of Ambient Particulates (GMAPS), The World Bank, Washington, D.C.

AIRPET (Regional Air Pollution Research Network for Improving Air Quality in Asian Developing Countries; [http://www.serd.ait.ac.th/airpet]) addresses integrated air quality management issues in Asian countries. The research project is coordinated by the Asian Institute of Technology (AIT) and is jointly conducted by 6 national research institutions from Asian developing countries, namely AIT, China, Indonesia, India, Philippines, and Vietnam.

The major objectives of first 2 phases (2001-2009) are to: (1) establish comprehensive assessment of air pollution status, (2) develop appropriate control technologies for developing countries, (3) apply modelling tools for integrated air quality management, and (4) develop integrated air quality management for target sources as demonstration cases. The major outputs of these first 2 phases are highlighted below.

AIRPET has created a long-term monitoring database of 7000 PM$_{2.5}$ and PM$_{10}$ samples collected in 2001-2008 with necessary QA/QC in 6 cities. In each city (Bangkok, Beijing, Chennai, Bandung, Manila, and Hanoi) PM monitoring was conducted at 3-5 characteristic urban sites and one remote site (outside the city). Samples were analyzed for mass and compositional data (EC/OC and/or BC, selected metals, and inorganic and organic ions). Higher levels of PM were observed during the dry season with daily PM$_{2.5}$ exceeded the WHO (2005) 24h PM$_{2.5}$ guideline of 25 μg/m$^3$ in all six cities for most of the monitoring periods (Kim Oanh et al., 2005). The levels of carcinogenic pollutants (BTEX, PAHs, pesticides and PCBs) were also found high in urban areas as compared to remote areas.

Receptor models (CM8, PMF, FA, COPREM, ME-2) revealed that diesel vehicles, biomass burning and secondary inorganic particles are the largest contributors to PM$_{2.5}$ in the cities, collectively contributed up to 80-90% of the PM mass.

3D air quality models (CMAQ/MM5, CAMx/MM5, and CHIMERE) were successfully evaluated and applied to analyze the efficacy of emission reduction scenarios on urban/regional ozone air quality in Bangkok, Hanoi, Jakarta and Hochimin City and the whole Southeast Asia region. Simulated ozone levels were high around large urban areas. The risk of surface ozone exposure on ecosystem/crops in Southeast Asia was assessed using AOT40 maps which show 3-month AOT40 significantly exceeding the WHO guideline (3000 ppb-h) over large parts of the region which suggest substantial reductions in agricultural crops yield.

Several lab-scales devices were developed and their performance was successfully evaluated with cost-benefit analysis.

These include the systems for BTEX, SO$_2$ and NOx (India), NOx and CO (Indonesia), VOC (China), and VOC & NOx (AIT). Two devices have been successfully scaled-up to pilot application in industries, namely for VOC control (China) and NOx control (India).

Integrated air quality management was developed for four target sources/source categories including open field rice straw field burning (AIT), brick making community (Vietnam), VOC industrial emission (China), and vehicle exhaust focusing on leaded gasoline (Indonesia). Recommendations from the demonstration cases study are also relevant for other countries where similar situations exist.

The AIRPET team actively involved in the result dissemination to public and policy makers. AIRPET regional workshops/trainings and national workshops were organized regularly. The team has produced over 70 peer-reviewed international journal articles, 100 peer-reviewed papers in international conference proceedings and conference presentations. The AIRPET team is in the process to publish a book “Air Pollution Management in Asia” based on the scientific output of the project.

Young researchers and graduate students involved actively in the project activities in all national partners. The research capacity of the involved NRIs had been improved substantially by human resource development and laboratory equipment. Networking was actively conducted with international networks (UNEP, World Bank, US-AEP, CAI-Asia, etc.) and national partners.

AIRPET phase 3 is planned for 2010-2011 with the overall goal to secure the remaining research results and continue research momentum, capacity building and networking. Main objectives are to (1) obtain long term trend of PM and BC, (2) apply satellite monitoring tool to assess the interaction between local and long range transport (LRT) and effects on urban air quality, and (3) promote co-benefit approach for air quality and climate change in Asia. One of the outputs of AIRPET phase 3 is a proposal of a new regional research project focusing on co-benefit for air quality and climate in Asia.

References
AIRPET website, 2009: [http://www.serd.ait.ac.th/airpet](http://www.serd.ait.ac.th/airpet)
Urban metabolism considers a city as a system and distinguishes between energy and material flows. “Metabolic” studies are usually top-down approaches that assess the inputs and outputs of food, water, energy, etc. from a city (Ngo and Pataki, 2008), or that compare the metabolic process of several cities (Kennedy et al., 2007). In contrast, bottom-up approaches are based on quantitative estimates of urban metabolism components at local scale, considering the urban metabolism as the 3D exchange and transformation of energy and matter between a city and its environment. Recent advances in bio-physical sciences have led to new methods to estimate energy, water, carbon and pollutants fluxes. However, there is poor communication of new knowledge to end-users, such as planners, architects and engineers.

The FP7 project BRIDGE (Sustainable Urban Planning Decision support accountinG for urban mEtabolism) aims at illustrating the advantages of considering environmental issues in urban planning. BRIDGE will not perform a complete life cycle analysis or whole system urban metabolism, but rather focuses on specific metabolism components (energy, water, carbon, pollutants). BRIDGE’s main goal is to develop a Decision Support System (DSS) which has the potential to propose modifications on the metabolism of urban systems towards sustainability (Chrysoulakis et al., 2009).

BRIDGE is a joint effort of 14 Organizations from 11 EU countries. Helsinki, Athens, London, Firenze and Giwice have been selected as case study cities. The project uses a “Community of Practice” approach, which means that local stakeholders and scientists of the BRIDGE meet on a regular basis to learn from each other. The end-users are therefore involved in the project from the beginning.

The energy and water fluxes are measured and modelled at local scale (Offerle et al., 2006). The fluxes of carbon and pollutants are modelled and their spatio-temporal distributions are estimated (Borrego et al., 2006). These fluxes are simulated in a 3D context and also dynamically by using state-of-the-art numerical models, which normally simulate the complexity of the urban dynamical process exploiting the power and capabilities of modern computer platforms (San Jose et al., 2008).

The output of the above models lead to indicators which define the state of the urban environment. The end-users decide on the objectives that correspond to their needs and determine objectives’ relative importance (weighting). The objectives weights reflect the central priorities of the project. Once the objectives have been determined, a set of associated criteria are developed to link the objectives with the indicators. BRIDGE integrates key environmental and socio-economic considerations into urban planning through Strategic Environmental Assessment (Donnelly et al., 2006).

The BRIDGE DSS evaluates how planning alternatives can modify the physical flows of the above urban metabolism components. A Multi-criteria Decision Making approach based on cost-benefit analysis has been adopted in BRIDGE DSS. To cope with the complexity of urban metabolism issues, the objectives measure the intensity of the interactions among the different elements in the system and its environment. The objectives are related to the fluxes of energy, water, carbon and pollutants in the case studies. The evaluation of the performance of each alternative is done in accordance with the developed scales for each criterion to measure the performance of individual alternatives.

Several studies have addressed urban metabolism issues, but few have integrated the development of numerical tools and methodologies for the analysis of fluxes between a city and its environment with its validation and application in terms of future development alternatives, based on environmental and socio-economic indicators for baseline and extreme situations. The innovation of BRIDGE lies in the development of a DSS integrating the bio-physical observations with socio-economic issues. It allows end-users to evaluate several urban planning alternatives based on their initial identification of planning objectives. In this way, sustainable planning strategies will be proposed based on quantitative assessments of energy, water, carbon and pollutants fluxes.

For more information: http://www.bridge-fp7.eu

References
Urbanisation has arguably been the most significant process of land use change in Europe since the Second World War. Over 70% of Europe’s population now lives in urban areas, which in turn have grown in area by almost 80% over the last fifty years (EEA, 2006). The most obvious signs of this shift towards urbanisation are urban sprawl and the emergence of peri-urban areas, characterised by scattered built-up residential, industrial or commercial areas and dense transport networks, but also by the establishment in some places of green belts, recreational facilities, rural woodlands and golf courses, the conversion of farmstead complexes into housing and changes from conventional agricultural land uses into hobby farms and rural areas within easy reach of the city.

The different spatial patterns, cultures, planning policies, and various driving forces of urban growth or decline, result in changes of land use and functional linkages between urban and rural areas. The changing nature of the relationships between rural and urban land uses has deep consequences both for people’s quality of life, for the environment and ecosystem services. These changes are most dynamic, intense and visible in the peri-urban zones which are therefore the main object of study. To understand the processes that drive land use changes, it is necessary to analyse the causes and effects, to improve knowledge, and to create better methods and tools to assess the future social, environmental and economic impacts of these changes. Only then can effective planning strategies to achieve sustainable land use systems be identified.

The PLUREL Project

The EC-funded research project, PLUREL, aims to achieve a deeper understanding of the changing relationships between urban and rural land use with an emphasis on the most dynamic portion, that of peri-urban areas. It develops methods and tools to assess the environmental, social and economic impacts of land use changes. Potential strategies and good practice examples will be identified in order to promote the sustainable development of land use systems in Rural-Urban Regions, especially the peri-urban.

A multi-level approach is essential, both to identify driving forces and pressures, and to explore policy responses and opportunities. Thus the results will be targeted to the pan-EU, national and regional levels of governance.

For the pan-European level typologies of Rural-Urban Regions and future scenarios for spatial development are developed. These scenarios are assessed for effects on land-use change, peri-urban land use relationships, as well as wider sustainability impacts, delivering outputs at NUTS2/3 level across the EU.

For the case study level detailed collaborative case studies and stakeholder scenarios for peri-urban development pressures, planning and governance systems – are combined with the development of quantitative land use scenarios, for the assessment of peri-urban land use relationships and sustainability impacts, both from regional policies and external driving forces.

End-Products

As its main end-products PLUREL will provide information and tools for analysis of peri-urban land use relationships and their sustainability. The end-products should provide outlook and inform decision making on peri-urban development at regional, national, and EU level.

The key end-product of the project will be the PLUREL Xplorer – a platform providing structured access to state-of-the-art knowledge on rural-urban land use relationships; and to a range of more interactive tools allowing exploration and analysis of sustainability impacts, land use dynamics, Quality of Life effects; as well as access to maps produced in the project.

The web-based and interactive tools will be supplemented by a book and a topical policy brochure for reference and support in policy development for the peri-urban.

International Conference in 2010

In 2010 - last year of the 4 year project – PLUREL will organise an international conference from October 18-21st in Copenhagen. The purpose is to present the status of scientific approaches for assessment of peri-urban land-use relationships and their sustainability effects; as well as setting the agenda for future research in the field. Abstract submissions are welcome until March 1st 2010.

References:

PLUREL website: [www.plurel.net](http://www.plurel.net)

International Conference, Managing the Urban-Rural Interface [www.plurel.net/conference](http://www.plurel.net/conference). Deadline for abstracts is March 1st 2010.

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EC FP6 Project CECILIA

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The aim of the CECILIA (Central and Eastern Europe Climate Change Impact and Vulnerability Assessment) project is to assess the impact of climate change at the regional to local scale for CEE using very high resolution in order to capture the effects of the complex terrain of the region. This goal is achieved using very high resolution RCMs run locally for targeted areas. Changes in weather patterns and extreme events are addressed within the project as they affect the important sectors for the economies and welfare of individual countries in the region. The selected applications of the CECILIA outputs are supposed toward water resources and management, agriculture, forestry, air quality and health.

Key issues

Emphasis is given to application of regional climate modelling studies at a resolution of 10 km for local impact studies in key sectors of the region, with selected domains for simulations committed by the partners as shown in Fig. 2. From the viewpoint of climate change scenario production two periods of time are planned, for 2020-2050 and 2070-2100. This CECILIA high spatial resolution of regional model experiments will feed into investigations of weather extremes in the region. Statistical downscaling methods for verification of the regional model results will be developed and applied, and assessments of their use in localization of model output for impact studies is performed. The objectives will be achieved through the tasks with the overall structure and dependencies within the project presented in Table 1.

Results

Example of regional climate change simulations is presented in Fig. 2. These high resolution simulations are at the final stage of the project used as a basis for further localisation effort, final scenarios construction and application in selected impact studies. In Fig. 3 and 4 we present examples of impacts on air-quality, which is of relevance to MEGAPOLI project. Not so substantial changes are seen in the mid-century decade, but end-of-century decade brings quite significant increase of days per year above the limit of 120 μg/m³ in Po Valley region, while the view in terms of average maxima shows the increase in Ruhr and Benelux region as seen in Fig. 4.

Table 1. Organization of individual tasks in workpackages.

<table>
<thead>
<tr>
<th>WP1</th>
<th>WP2</th>
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<tr>
<td>Assessment and validation of climate change information for downscaling and impacts</td>
<td>Statistical downscaling, localization, validation, and scenario construction</td>
<td>Regional climate modelling experiments</td>
<td>Climate change impacts in agriculture and forestry sectors</td>
<td>Climate change impacts in hydrology and water management</td>
<td>Climate change impacts on air quality and health</td>
<td>Climate change impacts on water resources and management</td>
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Figure 1. Simulation domains of individual targeted regions (partners).

Figure 2. Climate change signal in surface temperature of CUNI A1B simulation at 10km resolution (annual mean) in mid-century time slice (2021-2050, left panel) and end-of-century time slice (2071-2100, right panel), against control run 1961-1990

Figure 3. Climate change signal in average maxima of ozone concentration above 120 μg/m³ per year based on CUNI A1B simulation at 10km resolution in mid-century time slice (2041-2050, left panel) and end-of-century time slice (2091-2100, right panel), against control run 1991-2000

Figure 4. Climate change signal in number of days with ozone concentration above 120 μg/m³ per year based on CUNI A1B simulation at 10km resolution in mid-century time slice (2041-2050, left panel) and end-of-century time slice (2091-2100, right panel), against control run 1991-2000

Project Info

CECILIA - Central and Eastern Europe Climate Change Impact and Vulnerability Assessment, http://www.cecilia-eu.org
Contract No. 037005, 1.1.6.3.I.3.2 - Climate change impacts in central-eastern Europe, 1 June 2006 – 31 December 2009
The Laboratory of Heat Transfer and Environmental Engineering (LHTEE; http://aix.meng.auth.gr/lhtee/) belongs to the Energy Section, Mechanical Engineering Department of the Aristotle University Thessaloniki (AUTH; http://www.auth.gr/home/index_en.html). It has a long record of research and consulting activities, both at national and international level. Most of the research funds of the Laboratory originate from competitive programmes of the European Union. In the last years, the total annual turnover of the Laboratory has been of the order of 1 million €. The Laboratory has significant experience and expertise in meteorological and air quality modelling and air quality assessment. The Laboratory’s research work focuses on the simulation of transport and chemical transformation of pollutants in the atmosphere with the use of advanced air quality models, with main focus on the urban air quality assessment. The Laboratory is also involved in Air Quality Management through the assessment of various measures for reducing air pollution levels, and the analysis of the impact of industrial activities and major public works on air quality. The Laboratory also provides practical support to public authorities and the private sector within this area of activities through the development of integrated environmental assessment tools with the use of informatics technologies. In the frame of its consulting services, LHTEE is also significantly involved in the various activities of EEA’s European Topic Centre on Air and Climate Change.

**Role and contribution**

The AUTH/LHTEE role and contribution into the MEGAPOLI project include: coordination and strong involvement in WP4 as well as a significant role in WP2 and WP7. In WP4, AUTH/LHTEE will lead the investigation and testing of advanced physical and chemical parameterisations developed in WP2, and will describe the dispersion, transformation and removal processes of the pollutants across the mesoscale and urban scales. The coupled MEMO/MARS modelling system will also be used to relate meteorological patterns to urban air pollution episodes and to identify and quantify the contribution of the main local emission sources to the urban air quality. In WP2, numerical RANS and LES CFD simulations will be performed by AUTH/LHTEE for the systematic study of small-scale features in the urban canopy and their effect on the air flow, as well as for the description of the urban energy balance. In WP7, simplified approaches will be utilised for the assessment of interactions between megacities and climate change, leading to a hierarchy of models, depending on the detail of input data availability. A number of megacities will then be selected for implementation of the integrated framework, spanning multiple scales, from city to global.

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CNRS-GAME (http://www.cnrm.meteo.fr/present/cahier.htm) - the Groupe d’étude de l’Atmosphère Météorologique (GAME) is a joint research unit of the CNRS and the Centre National de Recherches Météorologiques (CNRM) of Meteo-France. The laboratory activities cover six main research topics including water cycle (processes, modelling, and assimilation), climate and climate change, ocean-atmosphere exchange, physics and chemistry of the atmosphere, urban meteorology, modelling and instrumental development.

The main objectives of CNRM are:
- making weather forecast more reliable and finer, in particular regarding early warning of high impact weather, and enriching weather forecast with an evaluation of its uncertainty and an assessment of the impacts to be expected;
- improving the performance of our Earth System model to reduce uncertainties on global and regional climate projections in order to deliver the knowledge which is necessary to mitigate climate change and to identify the best strategies for the adaptation of the territories.

One of the major areas of activity of CNRM-GAME concerns cloud and aerosol microphysics, the impact of aerosol on climate and health, the development of new airborne instrumentation, processing methods, parameterization of aerosol and cloud microphysics in multidimensional models, and of their effects for radiative transfer and precipitation formation.

CNRM has contributed to a number of EU projects within FP5-FP7 and is present in steering committees of several national, European and international programmes. CNRM is presently coordinating the EUFAR FP6 integrated infrastructure initiative aiming at integrating the activities of the European fleet of instrumented aircrafts in the field of environmental research.

Role and contribution
The CNRS-LGGE role and contribution into the MEGAPOLI project include airborne aerosol measurements in WP3 (chemistry). We were also part of the ground measurements at LHVP and SIRTA, in collaboration with people from LCP-Marseille (lead: Nicolas Marchand) (http://www.univ-provence.fr/lcp-ira) and LCME-Chambéry (lead: JL Besombes) (www.lcme.univ-savoie.fr).

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The Abdus Salam International Centre for Theoretical Physics (ICTP) has been founded in 1964 by Abdus Salam (Nobel Laureate). The ICTP operates under the aegis of UNESCO (United Nations Organization for Education, Science and Culture) and is regulated by a three-party agreement between UNESCO, the IAEA (International Atomic Energy Agency) and the Government of Italy, which provides the major part of the Centre's funding. The main mission of the ICTP is to foster the growth of advanced studies and research in physical and mathematical sciences, with particular emphasis on the developing countries. ICTP acts as an international forum for scientific contacts between scientists from all countries. It provides facilities to conduct original research for its visitors, associates and fellows and to organize schools, workshops and conferences (approximately 60 per year). On average, ICTP welcomes 3600 scientists a year. Over 50% of the scientists who have attended the ICTP activities since 1964 came from developing countries; until now, 150 nations and 45 international organizations have been represented. The main research fields of interest at ICTP are: Mathematics, Physics of Condensed Matter, Physics of High and Intermediate Energies, Earth System Physics, Physics of the Living State, Digital Communications and Computer Networking.

The Physics of Weather and Climate group was established in 1998 and then it was enlarged and became the Earth System Physics section (ESP) in 2005. It conducts research and educational activities on regional and global climate modelling, anthropogenic climate change, natural climate variability, predictability at seasonal to interannual and interdecadal scales, chemistry-climate interactions, biosphere-atmosphere interactions, seismology, physics of the lithosphere, earthquake prediction. The ESP maintains and develops a state-of-the-art regional climate model (RegCM). This model was developed and upgraded during the last two decades and has been used for a wide variety of applications, including paleo climate, land-atmosphere feedbacks, chemistry-climate interactions, air sea interactions, and future climate simulations at the regional scale. The RegM has been applied to most land regions in the globe (Europe and Mediterranean Basin, US, Africa, Central, East and South Asia, Central and South America) and has been run on horizontal grid intervals of 10-100 km. It has capability of interactive coupling to an aerosol model, different chemistry modules, a one dimensional lake model, a three dimensional ocean model (the MIT GCM) a dynamical vegetation scheme (CLM) and a biogenic emission module (MEGAN). The RegCM is currently used by a large community of users, including many from developing countries. They form the Regional Climate Research Network (RegCNET, Fig. 1), a community of scientists worldwide that regularly interacts through email and workshops. The ESP organizes 8-10 workshops and conferences per year on Earth Sciences, both at ICTP and abroad. It also organizes a one year diploma program in Earth System Physics.

It currently participates in EU projects (ENSEMBLES, CECILIA, WATCH, ACOWA), international projects (PIRCS, NARCCAP, CORDEX) and projects within the Italian National Climate Research Program (CMCC). The ESP has access to the supercomputing facilities of CINECA.

**Role and contribution**

The ICTP role and contribution into the MEGAPOLI project include the use RegCM3 (Regional Climate Model Version 3) both in uncoupled and coupled (with aerosol module) mode. The top-of-atmosphere radiative direct and indirect forcings and related climatic effects induced by megacity emissions will be calculated both off-line and on-line by RegCM3. The analysis of climate effects will include variables such as temperature, clouds, precipitation, circulation and the surface hydrological cycle, as well as radiation-aerosol interactions and cloud-aerosol interactions. The regional model simulations will focus on the European region and one extra-European domain, either Asia or Central America. Sets of regional simulations are planned, each of 10 to 20 years in length for present day and future climate conditions. The simulation period will include the special observing period planned in WP5. Each set will include three simulations, one without aerosol effects (control run), and the others including aerosol effects in uncoupled and coupled mode. Lateral chemical boundary conditions will be obtained from corresponding global model simulations (WP5 and WP6).

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Recent research work (funded by NERC/NCAS) concerns the use of WRF and CMAQ to understand the dynamical processes affecting exchange of air pollutants between urban canopy and the free tropospheric. Detailed evaluation of the performance characteristics of the models is assisting the Environmental Agency to make an informed decision on how complex models can be employed for regulatory applications. Outcome of this work is also relevant for the wider decision-making and policy formulation process related to air quality and health impact and European sustainable development action plans and strategies.

Role and contribution
The UH-CAIR role and contribution into the MEGAPOLI project include: (i) Integration of UK higher resolution emissions inventories into regional emission inventory and the influence of up-scaling of megacity emission to regional/global scales; (ii) Use of WRF with CMAQ to improve the treatment of downscaling processes for megacities from regional to urban scales and finer and evaluate their local to regional air quality impact; (iii) Application and demonstration of prototype modelling system for case studies and scenarios evaluation focusing on London and Paris megacities and (iv) Synthesising the main project outcomes to develop a framework for integrating models for the purpose of quantifying the impacts on and of megacities over regional to global scales.

Sulphate component of the aerosols on 25 Nov 2002 at 12UTC

CAIR expertise include: Modelling of weather and air quality, Satellite remote sensing and multi-scale modelling, characterisation and source apportionment of air pollutants, air quality science for health and policy, and megacities and trends in air quality. A special emphasis is being placed on the dynamical, physical and chemical processes that affect air quality on scales ranging from global down to turbulence scales. Nationally CAIR coordinates the UK’s mesoscale modelling network MESOMAQ which is an activity under the NCAS/Weather Directorate. It is also running other national projects including MESO-NET (funded by NERC) and CREMO (funded by the Environment Agency within the UK) both of which focus on modelling air quality on multiple scales.

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The Department of Physics, Division of Atmospheric Sciences at the University of Helsinki (UHel; http://www.helsinki.fi/university/) has over 25 years tradition in atmospheric research. 80 scientists and doctoral students are currently engaged in this area.

The main research subjects are aerosol dynamics (nucleation, condensation, coagulation, and deposition), formation and growth of atmospheric aerosol particles and cloud droplets, atmospheric chemistry, urban aerosols, forest-atmosphere interactions (fluxes, photosynthesis, water transport), aerosol-cloud-climate interactions, atmospheric boundary-layer theory, modelling and parameterization and satellite remote sensing. The basic theoretical resources consist of detailed computer codes describing basic phenomena such as multi-component nucleation and condensation, photosynthesis, and extensive models for aerosol dynamics, atmospheric chemistry and cloud microphysics.

The basic experimental resources consist of three field stations (SMEAR: I, II, III) and a state-of-art aerosol laboratory. In the field stations e.g. aerosol dynamics, atmospheric chemistry, micrometeorology, gas exchange between forest and atmosphere, soil chemistry and forest growth are measured continuously.

The Division (http://www.atm.helsinki.fi/) focuses on:

- Atmospheric aerosols: climate change and health effects
- Micrometeorology: interactions between ecosystem and the atmosphere, carbon sinks
- Meteorological modelling: climate research, development of weather forecast models, Martian gas sphere
- Weather radar - development of radar measurements

The scientists of the Division participate in international research projects such as:

- EUCAARI (European Integrated project on Aerosol Cloud Climate and Air Quality Interactions)
- iLEAPS (Integrated Land Ecosystem - Atmosphere Processes Study)
- CBACCI (Biosphere-Carbon-Aerosol-Cloud-Climate Interactions)
- PBL (Planetary-Boundary-Layer)
- ABS (Atmosphere-Biosphere-Studies Nordic Master Programme)
- Finnish Centre of Excellence (Physics, Chemistry, Biology and Meteorology of Atmospheric Composition and Climate Change)
- ICOS (Integrated Carbon Observation System)
- EUSAAR (European Supersites for Atmospheric Aerosol Research)
- IMECC (Infrastructure for Measurements of the European Carbon Cycle)
- GEOnet (Global Earth Observation and Monitoring)

Role and Contribution

The role and contribution of the University of Helsinki in the MEGAPOLI project include: responsibility for the aerosol science aspects including aerosol-climate interaction, ground based observations and remote sensing, and development of improved parameterization of the turbulent and mean structures of urban atmospheric boundary layers (UABLs) for use in climate and air quality models. Contribution also includes using eco-indications in MEGAPOLI: to update the concept of water eco-indices; to participate in elaboration of characteristics combining in integral indexes (Environmental Quality Indexes) for the system air-water.

Figure 1: Particle size distributions measured on the 31st of July 2009 during the intensive field campaign in Paris

Researches Involved

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Charles University (CUNI) founded in 1348 is one of the oldest universities in Europe and nowadays belongs to the most eminent educational and scientific establishments in the Czech Republic. CUNI now contains 17 faculties, 3 collegiate institutes, 6 additional establishments for educational, scientific, research and developmental activities and other creative activities and for information service, 5 university-wide facilities and the vice-chancellor’s/ rector’s office as an executive establishment for Charles University management. There are more than 7000 University employees, 4000 of them are academic and research workers. Over 42,400 students study at CUNI (approximately one fifth of all the students in the Czech Republic) in more than 270 accredited academic programs with 600 departments. 7200 students are studying for bachelor’s degrees, 29 000 students are studying for master’s degrees, and over 6200 students are in PhD programs. There are more than 4300 foreign students—750 of which study in English language academic programs. CUNI is an accredited public university, it is an autonomous scientific and educational establishment. The rector is head of CUNI; the Academic Senate is the supreme self-regulating academic organ. The deans are heads of faculties which are independent to a large extent. CUNI aims to be recognized as a competitive research university on the world stage. The scope of CUNI can be characterized also by its income amount which is cca 5 billion Czech crowns per year. 41% of this amount comes from educational funding, 27% from competitive research grants, and 26% is its own income.

The Department of Meteorology and Environment Protection (located in building Troja, see below) is a part of the Faculty of Mathematics and Physics of Charles University in Prague. The department provides training of students in subject field of meteorology and climatology in all degree programmes – bachelor, master and doctorate. In addition to training of experts in the field of atmospheric physics, the department contributes significantly to research focused on the weather, climate system or urban pollution. The graduates of Department have a wide knowledge of basic physics, especially physics of the atmosphere, and essential mathematical methods. They are able to deal with tasks in both basic and applied research or in wide meteorological practice (e.g., weather service). In particular, their knowledge consists of atmospheric dynamics, energetics and circulation and it can be used especially in numerical weather prediction, modelling of air-pollution transport, dispersion and transformation of air-pollution, modelling of climate, climate changes and anthropogenic impact on it. Alumni have a good knowledge of atmospheric optics, acoustics and electricity which allows them to participate in many technical applications, both research and operational ones.

**CUNI Team**

The team from the Department of Meteorology and Environment Protection (http://kmop.mff.cuni.cz/en/main) of the Charles University (CUNI; http://www.cuni.cz/UKENG-1.html) in Prague have expertise in a range of climate-related research topics including regional climate modelling and statistical evaluation of the reliability, sensitivity and uncertainty of model results comparing both with gridded climatology and station data. One of the main experiences of the team is in air-quality studies as well, mainly working on air-pollution modelling. Recently, mainly for EC FP6 IP QUANTIFY and EC FP6 STREP CECILIA, CTM CAMx has been coupled to RegCM model used for regional climate simulations and studies on interactions of chemistry and climate in high resolution on regional scale. CUNI has participated and coordinated in several EU, international and national projects, respectively. In addition, it has provided numerous consultations to local and national governmental authorities and Organizations in its field of expertise. In relation to the MEGAPOLI project mainly participation in FP6 projects ENSEMBLES, QUANTIFY and coordination of project CECILIA could contribute to the progress in the envisaged studies.

**Role and contribution**

The CUNI role and contribution into the MEGAPOLI project include: participating in WP6, CUNI will share the expertise in regional climate modelling in high resolution, impact of land use changes as well as the skill with coupling of air-quality CTM model to the regional climate model.

**Researchers Involved**

**Tomas Halenka**, doc.RNDr. CSc., (Associate Professor, Deputy Head of the Department). Experience and expertise in numerical modeling of the atmosphere, regional climate modelling, air quality modelling in local and regional scales, ozone, reading lectures on NWP, Dynamic Meteorology and others topics, supervisor of many diploma and doctoral student. Participation and coordination in several EU, international and national projects, coordinator of EC FP6 project CECILIA, participating in project FP6 EC ENSEMBLES, QUANTIFY, FP5 EC SOLICE. President of the Czech Meteorological Society, Vice-President and Treasurer of European Meteorological Society (2005-2007), Chairman of educational committee of EMS.
Coming and Recent Presentations and Publications

Dear colleagues, please, pay your attention to presentations and publications related to the MEGAPOLI Project:

- See more MEGAPOLI Publications/ Presentations at http://megapoli.info

Coming Conferences

Dear colleagues, please, pay your attention to conferences you might be interested to attend and/or present the MEGAPOLI Project results and findings:

- WMO, COST-728, MEGAPOLI End-user Workshop
  Geneva, Switzerland, 24-26 Feb 2010
  Contact Liisa Jalkanen (WMO Team), ljalkanen@wmo.int
- European Geosciences Union General Assembly (EGU-2010)
  Vienna, Austria, 2-7 May 2010
  (special MEGAPOLI, CityZen, MILAGRO session)
  http://meetings.copernicus.org/egu2010/
- 13th Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes; Paris, France, 1-4 June 2010
  http://www.harmo.org/harmo13
- International Aerosol Conference
  Helsinki, Finland, 29 Aug – 3 Sep 2010
  http://www.iac2010.fi
- 10th European Meteorological Society (EMS-2010) Annual Meeting and 8th European Conference on Applied Climatology (ECAC)
  Zurich, Switzerland, 13-17 Sep 2010
  (special MEGAPOLI session)
  http://meetings.copernicus.org/ems2010/