Megacities: Emissions, urban, regional and Global Atmospheric POLlution and climate effects, and Integrated tools for assessment and mitigation

Theme FP7-ENV-2007.1.1.2.1:
Megacities and regional hot-spots air quality and climate

SEVENTH FRAMEWORK PROGRAMME

MEGAPOLI-NL11-11-06 | **June 2011** | **Issue: 11**

Welcome to the 11th issue of the Newsletter

Editorial

The MEGAPOLI consortium is pleased to present the 11th 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@dmi.dk***).

Latest News

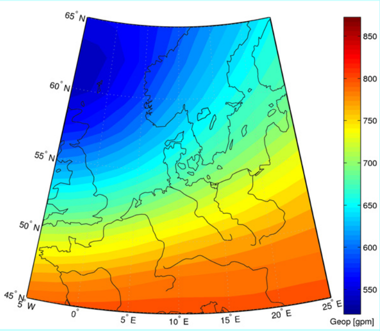
- **Coming soon** – Sep 2011 - Final Periodic Reporting to European Commission
- **Coming soon** – Final (3rd Annual Meeting) MEGAPOLI Project Symposium (Paris, France, 26-28 Sep 2011)
- **Coming soon** – Urban Air Quality and Climate Change Workshop (UAQCC) (16-18 Aug 2011, Hamburg, Germany)
- **25 May 2011** – "Megacities and GURME" meeting at the World Meteorological Congress
- **24 May 2011** – 7th MEGAPOLI WP Leaders Telephone Conference
- **30 Apr – 3 May 2011** – International workshop "Integration of geospheres in earth systems: Modern queries to environmental physics, modelling, monitoring & education" (Dubrovnik, Croatia)
- **26-28 Apr 2011** – WP3: "Megacity plume case study" workshop (Villigen, Switzerland)
- **4-5 Apr 2011** – MEGAPOLI related session at EGU-2011 and Splinter Meeting with CityZen and MILAGRO projects
- **8 Mar 2011** – MEGAPOLI presented in the "Eggs" (EGU NewsLetters)

EGU-2011: Megacities Session and Splinter Meeting

4-5 Apr 2011 – MEGAPOLI related session AS3.6 "*Megacities: Air Quality and Climate Impacts from Local to Global Scales*" at the European Geosciences Union General Assembly 2011 (EGU-2011, Vienna, Austria, 3-8 Apr 2011) with invited talk on MEGAPOLI by Spyros Pandis (FORTH Team); and Splinter Meeting with CityZen and MILAGRO

- **4 Apr 2011** - Mon, 08:30-17:00 - AS3.6 Session "Megacities: Air Quality and Climate Impacts from Local to Global Scales" (Oral presentations); Convener: Michael Gauss, Co-Conveners: Luisa Molina, Alexander Baklanov); with a number of MEGAPOLI project related presentations
- **4 Apr 2011** - Mon, 17:30-19:00 - AS3.6 Session "Megacities: Air Quality and Climate Impacts from Local to Global Scales" (Poster presentations)
- **5 Apr 2011** - Tue, 08:30-10:00 - MEGAPOLI/ CityZen/ MILAGRO joint splinter meeting of the MEGAPOLI, CityZen and MILAGRO projects (Introduction - by Alexander Baklanov; status and progress on projects - CityZen - by Michael Gauss, MEGAPOLI - by Alexander Baklanov, MILAGRO - by Spyros Pandis; and followed discussions lead by Mark Lawrence; summary notes of the meeting - by Alexander Mahura); Attended - 27 persons (MEGAPOLI - 16; CityZen - 8; MILAGRO - 1; other projects - 2) from 13 countries and from 22 research organizations/ institutions (list of participants); *see details at the MEGAPOLI internal website*
- **5 Apr 2011** - Tue, 10:30-12:00 - MEGAPOLI working meeting (progress and finalization of tasks, deliverables, and milestones hve been discussed; separate WP6, 7, and 8 phone-conferences have been planned, in addition to the re-scheduled MEGAPOLI WP Leader phone-conference)

Content



Clusters based on 925 hPa geopotential height data for 2005; weather type 7 (Del 7.2)

Global Emission Data for use in the MEGAPOLI project (MEGAPOLI Del 1.5)

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The fundamental approach of the MEGAPOLI project is the bridging of spatial scales, from the street scale to the global scale, in the study of megacities and their influences on air quality and climate. This approach requires the use of a wide range of models, from fine-scale turbulence-resolving models able to compute the flow deformation due to elements of the urban canopy, to regional models, which simulate the detailed effects of individual urban centres or agglomerations on their local surroundings, all the way up to global models, which can simulate the combined effects of all megacities on large-scale pollutant plumes and on the global climate system.

In general these models require emission data as boundary conditions, in order to correctly simulate the evolution of the chemical composition of their particular atmospheric domain. Within the MEGAPOLI project there are several different models covering each of the relevant scales. The use of a large suite of models allows better estimation of the between-model uncertainty. When all models use the same emission inventory it is easier to compare their results. The emission inventory used by the regional models in the MEGAPOLI project was described in the last MEGAPOLI newsletter (March 2011). This regional inventory includes nested high resolution data of the Paris region. Here we describe the emission inventory used by the global models in the MEGAPOLI project.

In consultation with the global modelling groups in the MEGAPOLI project it was decided to use an emission inventory which was already available to the scientific community; the CMIP 5 project global emission inventory (Coupled Model Intercomparison for the upcoming IPCC AR5 report). The processing of this inventory for specific MEGAPOLI tasks is described in detail by *Butler et al. (2011).*

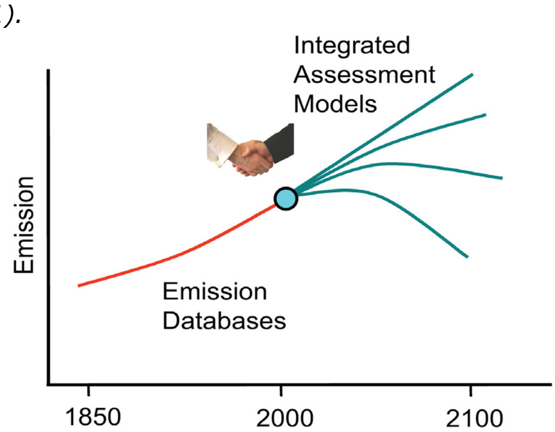

Figure 1. The handshake process, illustrating the link between historical and future emissions (Lamarque et al., 2009)

The emission data is based on a set of historical emission data produced by *Lamarque et al. (2010)*, which extends from the year 1850 to the year 2000, with data available for each decade. Beyond the year 2000, emission data is obtained from a set of Representative Concentration Pathways (RCP) which describes a range of possible future development pathways and their associated emissions. These RCP are harmonised with the historical emission data using a "handshake" approach, as illustrated in Figure 1. RCP data are available for the year 2005 as well as for every decade up to the year 2100. The base year for the global model runs in the MEGAPOLI project is set as the year 2005, which is projected from the latest available historical emissions for the year 2000 through the RCP 8.5 pathway (*van Vuuren et al., 2007*).

Each global modelling group will perform simulations using this base year. Depending on the available resources, different global modelling groups will also perform simulations for a number of future scenario years drawn from several of the available RCP datasets.

An important aspect of the global modelling for the MEGAPOLI project is the use of a megacity "mask" in order to identify points in the gridded global emission dataset which correspond with the geographical location of the megacities under consideration. Previous work had used a mask at a spatial resolution of 1 x 1 degrees. In order to take advantage of the higher resolution of these newer emission data, a new mask at a spatial resolution of 0.5 x 0.5 degrees was developed using a new procedure based on the emissions distribution. An example of the application of this new mask is shown in Figure 2. Since the emissions originating from the megacities are now identified, we can investigate what the impact of these emissions is on air quality and regional climate.

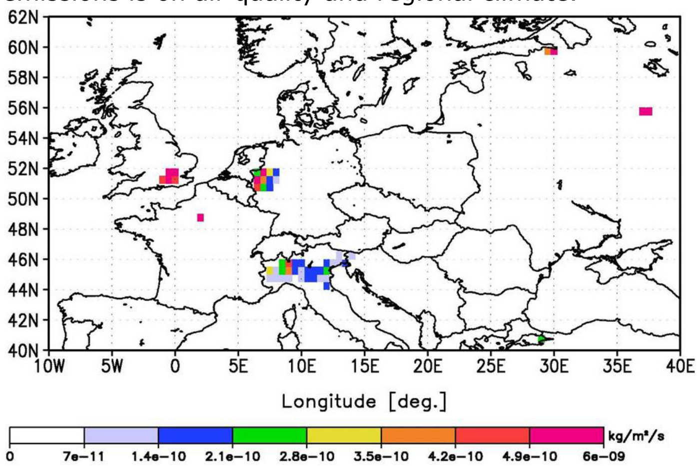

Figure 2. *Zoom from the global emission map after applying the new megacity mask: NOx emissions from the European megacities in 2005*

References

Butler T., H.A.C. Denier van der Gon, J. Kuenen (**2011**): The Base Year (2005) Global Gridded Emission Inventory used in the EU FP7 Project MEGAPOLI (Final Version). MEGAPOLI Scientific Report 11-02, MEGAPOLI-28-REP-2011-01, 27p, ISBN : 978-87-92731-06-7 http://megapoli.dmi.dk/publ/MEGAPOLI_sr11-02.pdf

Lamarque, J.-F et al. (**2009**), Gridded emissions in support of IPCC AR5, IGAC newsletter, 41, May 2009 http://www.igac.noaa.gov/newsletter/igac41/May2009_IGAC_41.pdf

Lamarque, J.-F et al., (**2010**), Historical (1850–2000) gridded anthropogenic and biomass burning emissions of reactive gases and aerosols: methodology and application, Atmos. Chem. Phys., 10, 7017-7039.

Van Vuuren et al., (**2007**), Stabilising greenhouse gas concentrations at low levels: an assessment of reduction strategies and costs, Clim. Change., 81, 119-151.

Evaluation and Improvement of Regional Model Simulations for Megacity Plumes (MEGAPOLI Del 5.3)

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As shown in a series of studies, integration of several independent modelling tools into modelling ensembles can substantially improve the accuracy of the predictions. To study the potential of this type of the model integration, within MEGAPOLI WP5 a multi-model ensemble of regional computations has been assembled for two periods: baseline year 2005, and Paris intense observational campaign in July 2009.

Five regional models (CHIMERE, FARM, LOTOS-EUROS, SILAM, and WRF-CMAQ) have submitted their data for the campaign period of 2009. Computations for 2005 were performed and supplied for the comparison and ensemble analyses by four models (CHIMERE, FARM, SILAM, and LOTOS-EUROS).

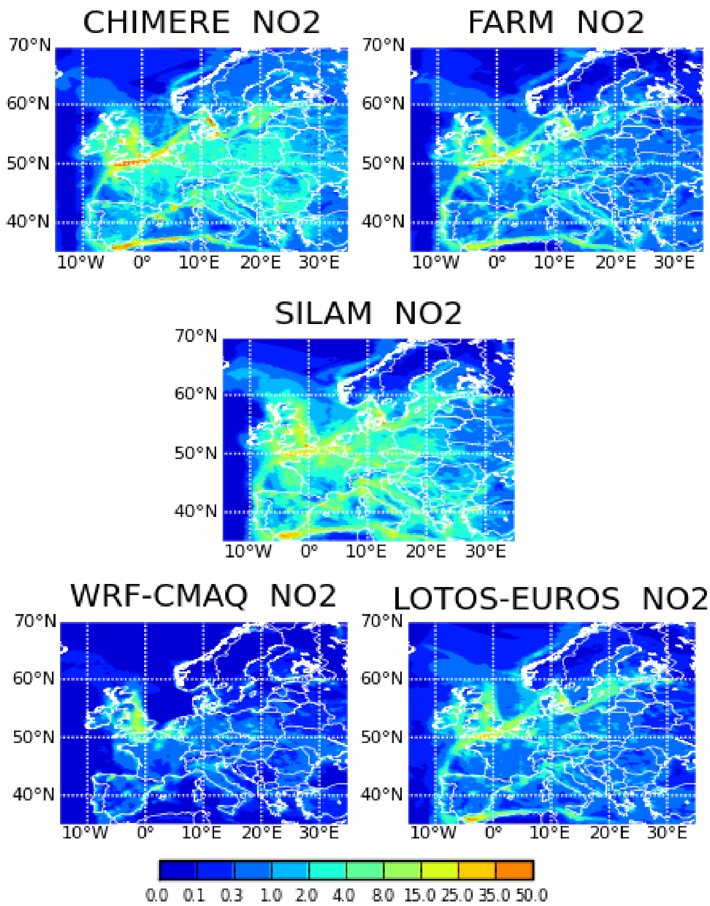

Figure 1. *NO_2 near-surface concentrations from MEGAPOLI regional ensemble for 1.7.2009.*

A series of ensemble based estimates were generated based on the individual datasets: simple ones, such as arithmetic average and median, as well as observation based adaptive estimates using the Airbase observations.

Assembling the multi-model ensemble allowed to perform an objective inter-comparison of the predictions of the participating models (made within the scope of this WP5 and the WP7, deliverable 7.3) and to estimate the extent to which the predictions of the individual models can be improved by means of multi-model ensemble.

It was found that the individual models are performing generally similarly for well-verified gaseous pollutants, such as NO_2, SO_2, and O_3. Out of these, the most difficult pollutant to be modelled was SO_2, for which all models have shown very low correlation with the observed time series, being generally close to the mean values. A series of specifics of some of the models were identified and communicated to the model developing groups for investigation.

In addition to the general similarity of the patterns computed with the above-mentioned models, the inter-comparison showed systematic differences between the model predictions. The differences between the model predictions are of the same order of magnitude than the differences between the individual models and the observations. The reasons for the particular behaviour of each model are time-, region-, and model- specific and have to be analysed separately for each episode.

Contrary to previous findings with other multi-model ensembles, the results showed that vertical profiles of the models are quite comparable, so that the difference between the predicted fields does not increase significantly with height above the surface.

In line with the previous experience, the differences between the model predictions for the compounds not verified routinely can be very large. More efforts are evidently needed to better understand and verify the modelling systems for these species.

It was demonstrated that application of even simple ensemble based estimates leads to improvement of the predictions. However, the effect varies among the compounds. The strongest improvement was obtained for optimising ensemble treatment applied to $PM_{2.5}$ and PM_{10} predictions where these methods eliminated the under-estimation and kept the predicted spatial pattern of the concentrations. Neutral impact was found for SO_2 whereas for O_3 the ensemble average appeared to be superior to the optimising methods. The reasons for such behaviour are under investigations.

Apart from the main multi-model ensemble analysis, the deliverable report includes a series of individual model studies, which are complementary to the main line. The analysis of the LOTOS-EUROS simulations with two versions of the emission inventory showed substantial changes of the PM concentrations over Paris. The experiment with the SILAM model showed the dependence of the results on the resolution and robustness of the area-totals to the computational setup. The analysis of the urban effects and aerosol feedbacks on the meteorology was made with the Enviro-HIRLAM model. The detailed analysis of the aerosol composition over Paris during the summer campaign and Mexico city was made with the PM-CAMx model. Finally, the report included an outlook of presently operational chemical weather forecasting systems in Europe.

References

*Sofiev M., M. Prank, J. Kukkonen (Eds) (**2011**): Evaluation and Improvement of Regional Model Simulations for Megacity Plumes. Deliverable D5.3, MEGAPOLI Scientific Report 11-04, MEGAPOLI-30-REP-2011-03, 88p.* http://megapoli.dmi.dk/publ/MEGAPOLI_sr11-04.pdf

Comparison of Coupled and Uncoupled Chemistry in a Global Model (MEGAPOLI Del 6.4)

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Using HadGEM2, the Hadley Centre has been addressing the differences in aerosol abundances and radiative effects between climate model runs with and without coupled chemistry for present day conditions. The target years for the study were the 10 years centred on 2005. The chemistry coupling was achieved by allowing radiative forcing from ozone, methane and aerosols. The coupled aerosols were also allowed to have indirect effects on clouds. The impact on aerosol distribution between coupled and uncoupled runs was found to be dependent on species with black carbon from fossil fuels having the more consistent signal away from the source.

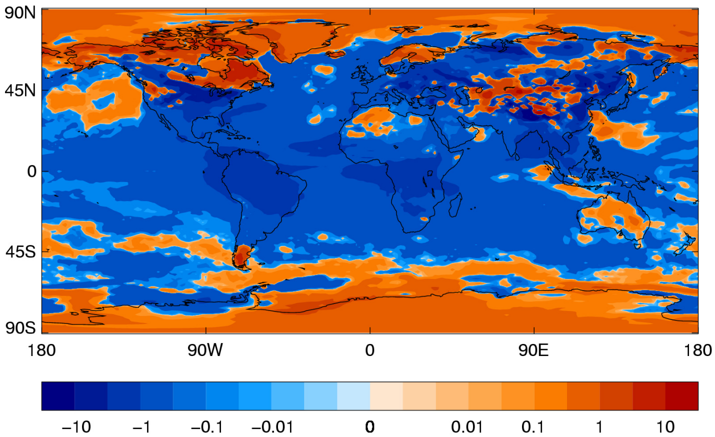

Figure 1. *Annual mean SW TOA clear sky aerosol forcing (W/m^2). Coupled minus Uncoupled.*

The difference in clear sky radiative forcing between coupled and uncoupled model runs has a generally negative response in equatorial regions and a positive response in polar regions (Fig. 1). The global mean signal is negative at -0.339 W m^{-2} and is dominated by the equatorial response. This is largely due to the increased presence of scattering sulphate aerosol in the coupled runs at these locations. The positive response in the polar regions results from the increased presence of black carbon in the coupled run allowing more radiation to be absorbed over the bright surface than would otherwise be the case. The polar signal can be seen to be significant (not shown), with coupled mean being at least 4 standard deviations away from uncoupled mean.

The surface concentration of aerosol is affected by chemistry coupling as the coupling has an impact on radiation and aerosol formation and removal mechanisms especially those connected with clouds and rainfall.

The sign of the difference depends on location and aerosol type. However, averaged over the globe, there is more aerosol at surface level when coupled than uncoupled.

The difference in magnitude is similar between the aerosol types (~0.03 μg m^{-3}) with sulphate showing the largest global change of 0.032 μg m^{-3}. OCFF (organic carbon from fossil fuel use) is 0.026 μg m^{-3} larger when coupled and black carbon is 0.025 μg m^{-3} greater.

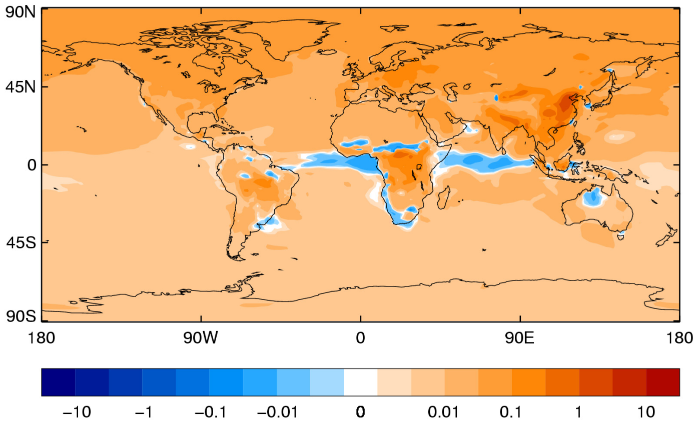

Figure 2. *Differences in surface concentration of black carbon from fossil fuels between coupled and uncoupled runs [μg m-3]. The difference is the mean of the coupled chemistry years minus the mean of uncoupled chemistry years.*

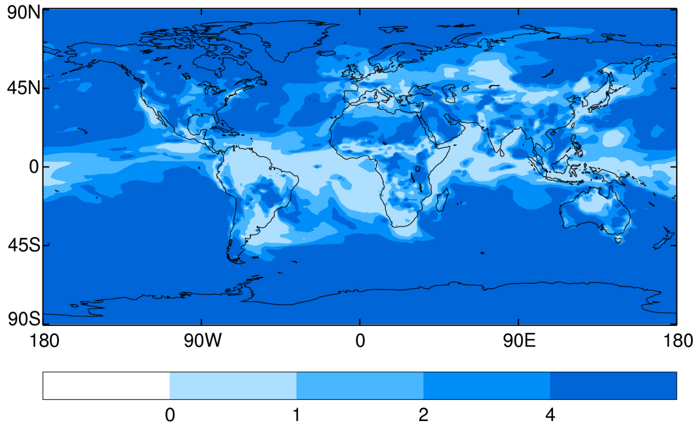

Figure 3. *Number of standard deviations the mean of the coupled years is away from the mean of the uncoupled years shown in Fig. 2.*

The signal is noisy for sulphate and OCFF with low significance in general. Although there appears to be large significance over Greenland and the polar regions, the signal strength is low. The effect on black carbon can be seen in Fig. 2 and demonstrates a much clearer positive signal. The remote signal appears significant (see Fig. 3) as the mean of the coupled runs is more than 4 standard deviations away from the mean of the uncoupled runs. This indicates that there is more long range transport of black carbon in the coupled runs and less deposition close to the source. This effect is a consequence of the experimental design and can be explained by cloud droplet number concentration (CDNC). This is held at fixed values (one value for sea and one for land) in the uncoupled run. In this model, when aerosols are coupled, it transpires that CDNC is lower than when uncoupled. This results in less removal by diffusional scavenging over the longer ranged transport.

From the analysis of the present day years, the differences in sulphate and OCFF do not appear significant between coupled and uncoupled runs. Black carbon surface concentration and burden however do show significant differences between coupled and uncoupled experiments regionally. The resultant impact on radiative forcing has a significant impact on the polar radiation budgets.

References

*Rumbold S.T., W.J. Collins, G.A. Folberth (**2010**): Comparison of Coupled and Uncoupled Models. Deliverable D6.4, MEGAPOLI Scientific Report 10-20, MEGAPOLI-23-REP-2010-11, 15p, http://megapoli.dmi.dk/publ/MEGAPOLI_sr10-20.pdf*

Evaluation of Integrated Tools (MEGAPOLI Del 7.2)

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The evaluation of Air Quality (AQ) models is very important for checking their applicability. Within MEGAPOLI an evaluation methodology has been developed that is applied to full-year model simulations performed for 2005. Results of a first model evaluation of CHIMERE, FARM and SILAM are summarised in *Schluenzen et al. (2011).* These models are of somewhat different complexity and thereby differ in process requirements, operational aspects, levels of integration, interfaces between meteorological and the actual air quality models. The evaluation methodology follows the COST 728 / ACCENT concept and includes a general and scientific evaluation. The benchmark test case is the full year 2005, which is used for a diagnostic, dynamic and probabilistic evaluation. Furthermore, the results for 2005 are used for the operational evaluation. All evaluations are done using routine observational data. Routine observations of the station network of the Landesamt für Natur, Umwelt und Verbraucherschutz (LANUV) have been used. The operational evaluation includes not only annual means but also exceedances. Focus of the evaluation method is on concentrations of PM, O_3, NO_2. All in all the models agree quite well (Fig. 1).

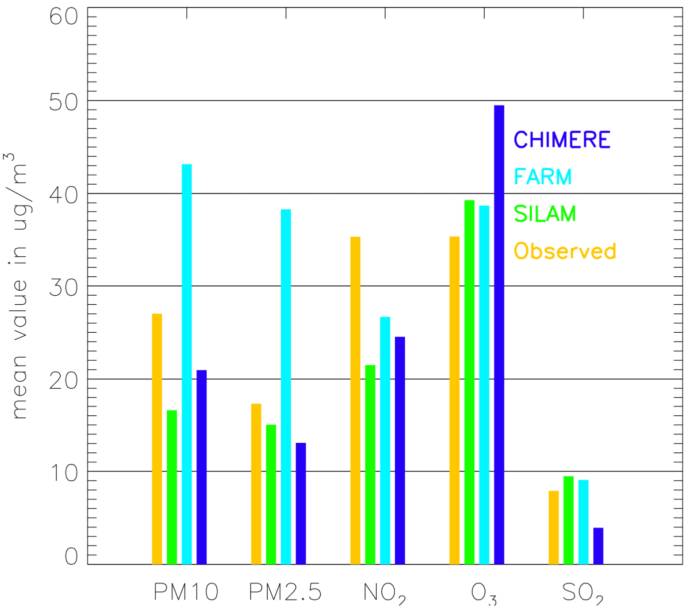

Figure 1. *Annual mean concentration values of the pollutants PM10, PM2.5, NO_2, O_3 and SO_2 at LANUV stations.*

For diagnostic and dynamic evaluation meteorological parameters are evaluated as well and the evaluation is done in dependence of the meteorological situation, which is characterised by clustering all days of 2005 into 9 weather-types.

Mean values of temperature and wind are well represented, the hit rates reach values over 50% (see Figure 2) and thus in the range found for other meteorology model evaluations in literature. The differences found for the annual average of meteorological parameters are consistently found for different weather situations.

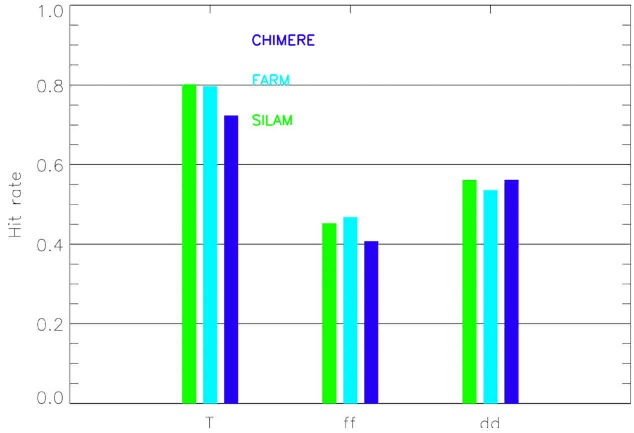

Figure 2. *Hit rates of temperature T, wind speed ff, wind direction dd for 2005. Note that the meteorological data evaluated are input data of CHIMERE, FARM, SILAM; they are not calculated in the AQ models themselves.*

The AQ models reach a different agreement with observations for the different chemical components. Systematic underestimations (overestimations) were found for PM10 for CHIMERE and SILAM (FARM). This results in too low (high) frequencies of exceedance. For ozone the low concentrations were simulated too high, the high concentrations slightly high (CHIMERE, FARM) or too low (SILAM). The differences are not only visible in the annual average data but also in different weather situations and might therefore not be a result of the meteorology, but of chemical reactions, of emission data composition or of a model internal origin. The too low NO_2 values can partly be explained by the too high ozone values found for many meteorological situations but not for all (Fig. 3).

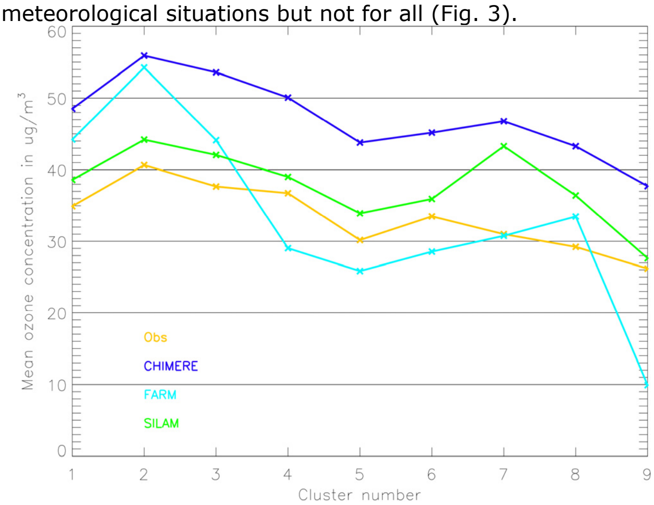

Figure 3. *Mean values of O_3 concentration in dependence of weather types at LANUV stations.*

From the evaluation study it can be concluded that the introduction of weather clusters and frequency distributions of model results and observations into the model evaluation can indeed help to better understand reasons for differences. The results already triggered investigations of the input and comparison data, as well as model internals. The model simulations will be extended and the method be applied in MEGAPOLI to analyse more model results for 2005 in additional European regions.

References

*Schluenzen, K.H., M. Haller, M. Beekmann, G. Bedbur, K. Conrady, S. Finardi, S. Gimmerthal, D. Grawe, P. Hoffmann, S. Pandis, M. Prank, V. Reinhardt, O. Ross, C. Silibello, G. Siour, M. Sofiev, R. Sokhi, J. Theloke, M. Uphoff (**2011**): Evaluation of Integrated Tools. MEGAPOLI Scientific Report 11-03, MEGAPOLI-29-REP-2011-03, 51p, 978-87-92731-07-4 http://megapoli.dmi.dk/publ/MEGAPOLI_sr11-03.pdf*

Short, Medium and Long Term Abatement and Mitigation Strategies for Megacities (MEGAPOLI Del 8.1)

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Introduction

The collection of mitigation measures and policy options for reducing the impact from Megacities to climate change and air pollution and vice versa is a crucial basis to collect mitigation measures and policy options distinguished by short term options and measures, that can be implemented more or less until ca. 2010 (e.g. traffic restrictions, city toll), medium term measures, that include changes of infrastructure and can thus be implemented in 2020. In addition long term mitigation and policy options (for 2030 to 2050) including structural changes, e.g. shift of industrial activities or living places to other areas are analysed; urban planning projects methodologies are used to develop scenarios of possible evolutions of the megacities London (centric structure) and Rhine-Ruhr (polycentric structure), i.e. a qualitative description of the possible development of settlement structure and infrastructure and development of assumptions about the effect of these scenarios on transport, energy supply and emissions of air pollutants have been developed.

Methodology

Relevant abatement measures for the sectors road traffic in cities, other mobile machineries, small and large combustions plants and industry have been identified and developed with focus to Megacities. The abatement measures have been developed for air pollutants and greenhouse gases. The abatement potential, cost and Synergies/interactions with other environmental objectives (e.g. climate change) and the implementation options of all measures have been assessed. The implementation of mitigation options was grouped into short (2010/2020), medium (2020/2030) and long (2050) term time scales.

Both technical measures (changing emissions factors, e.g., an additional filter) and non-technical measures (which change the decisions and the behaviour of users of emission sources, e.g., by implementing a charge on emissions) have been addressed.

The long (2050) term measures about the options and effects of long term city planning and urban management in the long run (including changes in the number of inhabitants and working places), how beneficial are these changes (e.g. better air quality, but higher energy demand, if population density decreases) and what is the potential of such changes are under development at moment.

Results

In our study - 9 measures related to road transport, 4 measures related to other mobile sources, 2 measures related to large combustion plants, 5 measures concerning small and medium combustion plants and 4 industrial related measures for the concerned megacities have been identified and described. Some of these measures can be applied only to the MC and others can be applied EU-wide, but also in MC areas.

For the sector "*on-road traffic*" has been developed the following measures:

- Enhanced use of bicycles in cities,
- Enhanced use of public traffic,
- Promotion of low emission vehicles (E-cars, hybrid vehicles),
- Traffic management (Green Wave, improvement of the operation of signalized intersections),
- Low emissions zones,
- City toll,
- Increase in fuel costs,
- Passenger car toll,
- Enhanced use of biofuels.

For the sector "*other mobile machineries*" has been developed the following measures:

- Differentiation of track access charges for rail transport,
- Further development of emission limits in inland waterway transport,
- Kerosene tax for aviation,
- Low emission zones for construction equipment.

For the sector "*Large combustion plants*" has been developed the following measures:

- Modernisation of the existing coal-fired Large combustion plants,
- Expansion of electricity generation from renewable resources in LCP.

For the sector "*Small combustion plants*" has been developed the following measures:

- Replacement of solid fuels fired small combustion plants with efficient combustion techniques,
- Replacement of old gas/oil boilers with modern condensing boilers,
- Energy-efficient modernisation of old buildings,
- Switch to renewable heat supply in residential sector,
- Expansion of district heating network.

For the sector "*Industry*" has been developed the following measures:

- Combined climate protection measures in cement industry,
- Iron & Steel production – Blast furnace - Injection of pulverized coal (PCI),
- Sinter plants – Heat recovery,
- Cokery plants – Coke dry quenching.

Outlook

In addition two urban development reference scenarios for the Rhine-Ruhr area (polycentric structure) and London (centric structure) about the future development of settlement structure, population growth and land use statistics - have been developed. On base of this will be modeled three hypothetical scenarios for future development of the different kind of urban structures: "The network model of the city", "Re-urbanization" and "Urban Sprawl"/"Disperse development". Another focus for further work is the investigation of future urbanisation effects to megacities on the global scale.

References

*Kampffmeyer T., U. Kugler, M. Uzbasich, J. Theloke, R. Friedrich, D. van den Hout (**2011**): Short, Medium and Long Term Abatement and Mitigation Strategies for Megacities. Deliverable D8.1, MEGAPOLI Scientific Report 11-06, MEGAPOLI-32-REP-2011-05, 40p, ISBN: 978-87-92731-10-4 http://megapoli.dmi.dk/publ/MEGAPOLI_sr11-06.pdf*

Ozone and Carbon Monoxide Signatures from Different Continents and the Bosnywash Area in the European Free Troposphere

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In this study the influence of the large emissions of the North American East coast megalopolis (Boston, New York, Washington, collectively named Bosnywash in the following) on atmospheric composition over Europe is assessed.

Method

We used a large data set of carbon monoxide (CO) and ozone measurements from the MOZAIC program to examine the influence of Bosnywash, as well as total North American, European and Asian emissions on the chemical composition of the atmosphere over Europe. For 1 km vertical averages of the MOZAIC aircraft measurements taken during take-off and landing over Central Europe, the Lagrangian particle model FLEXPART (Stohl et al., 2005) is used to identify the modelled CO contribution of each of the 4 mentioned regions. For each measurement 40.000 particles were released and followed 20 days backward in time, anthropogenic CO emission inventories were used to model the estimated CO contribution. We define an air mass being influenced by a certain region if more than 70% of the modelled total CO is coming from this specific region. For the Bosnywash area, however, we request a contribution of only 20%, as much higher contributions are rare. The data series for ozone spans a period from 1995-2009 while CO was measured since 2002. The model also estimates the stratospheric contributions to each measurement. Samples with a higher than 5% stratospheric contribution are not used in this analysis.

Influence of different continents

As all the measurements were taken over Europe, there is a dominant influence of European emissions in the lowest 4 km (Fig.1, yellow line). North American dominated measurements become most abundant between 4 and 8 km (Fig. 1, blue line), with more than 5000 measured ozone values are used. Asian dominated air masses are most frequent at about 8 km but peak at only about 2000 cases.

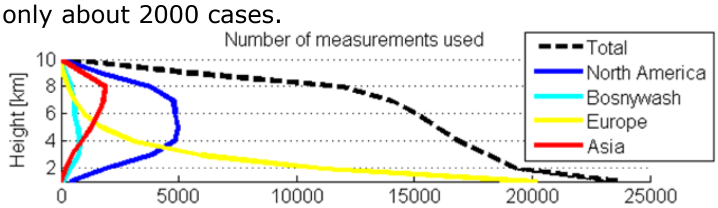

Figure 1. *Frequency of non-stratospheric ozone measurements dominated by one continent/Bosnywash area as a function of height. The period from 1998 to 2009 is used and the measurements were taken in a box over Europe extending from 45N to 55N and from 10W to 20E.*

Screening the dataset for all observations, which had an influence >70% from one continent or >20% from the Bosnywash area, it was found, that while 22% of the observations were dominated by North American emission, only 3.5 % are coming from the Bosnywash area. European emissions dominate with 66.5%, while the contribution of modeled CO from Asia is 10%.

In order to estimate how strong the European free troposphere is influenced by the specific source regions, modelled CO contributions for each continent, as well as seasonal deviation from the mean mixing ratios is calculated for each region respectively (Fig. 2).

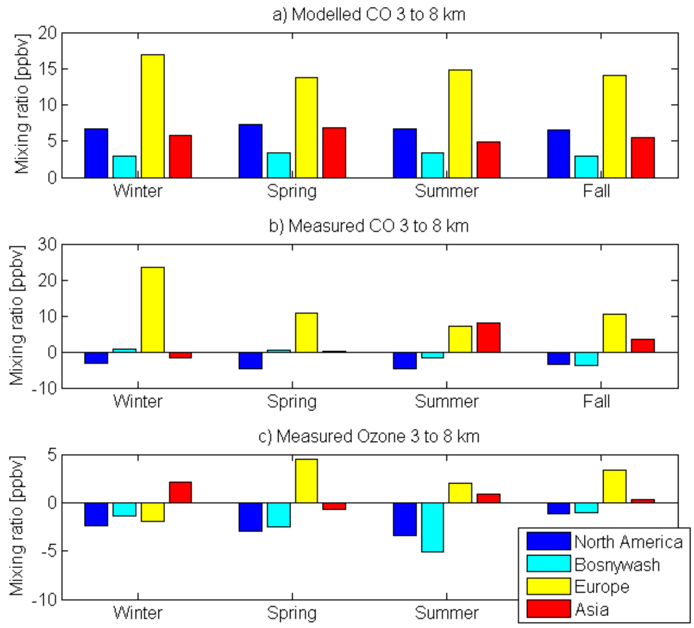

Figure 2. *Seasonal averages for modelled CO due to emissions from the last 20 days before sampling, grouped by the dominating source region (upper panel) over an altitude between 3 and 8 km. Measurements of CO and ozone (lower two panels), averaged over times when a certain continent/region had a dominating influence. Positive values indicate that when the air mass is mainly influence by one continent the measured mixing ratios are above average. The statistic for ozone is performed over the same time period as Figure 1; for CO, data from 2002 to 2009 were available.*

The modelled and measured CO (upper two panels of Figure 2) show that the highest measured/modelled CO values occur in air with dominant European emission influence. The model estimates somewhat more than 50% smaller mixing ratios when air is dominantly influenced by North American and Asian emissions, the measurements show a stronger Asian than North American enhancement. In summertime, air masses coming from the Bosnywash area have higher CO, but lower ozone than from other regions in North America. This is different in winter and spring, where air masses from the Bosnywash region have higher ozone values than North American influenced ones.

Acknowledgements

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Estimation of NO_x Emissions from Delhi using Car MAX-DOAS Observations and Comparison with OMI Satellite Data

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The first Multi-Axis- (MAX-) DOAS observations in Delhi (India) and nearby regions were performed during April 2010 and January 2011. The MAX-DOAS instrument was mounted on a car roof, which allowed to perform mobile measurements. From car MAX-DOAS observations along closed circles around Delhi, together with information on wind speed and direction, the NO_x emissions from the greater Delhi area were determined.
The total NO_x emissions were derived from observations along closed circles around the city. Since the MAX-DOAS observations encircled only part of the entire Delhi area, the results obtained have been up-scaled. For that purpose, three different proxies were used - the spatial distribution of:

- NO_x emissions from the EDGAR data base,
- population density,
- light intensity observed from satellite during night (Fig. 1).

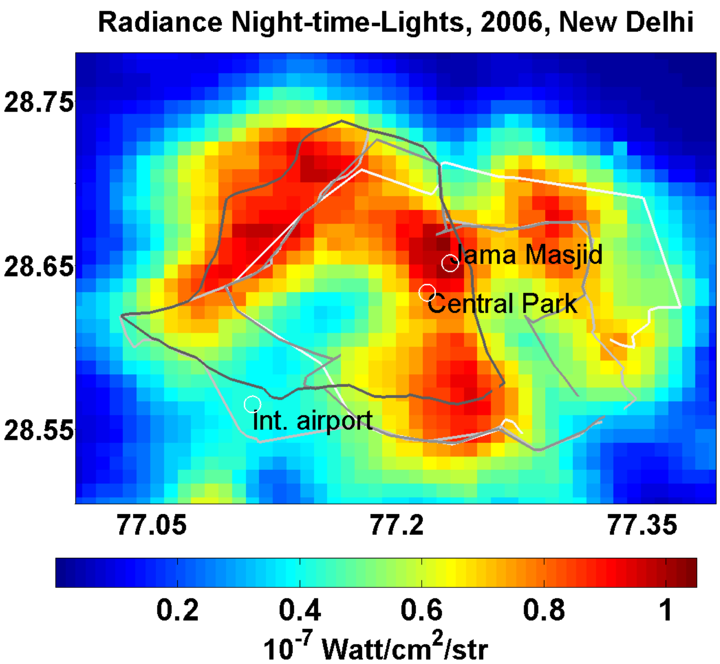

Fig. 1. *Spatial distribution of the night-time lights for the selected Delhi area, which is used to estimate the fraction of the encircled emission. Also shown are the driving routes for the different days.*

Our emission estimation for Delhi, 3.7×10^{25} molec/s, is slightly lower than the corresponding emission estimates using the EDGAR data base and substantially smaller compared to a recent study by *Gurjar et al. (2004)*, (see Figure 2).

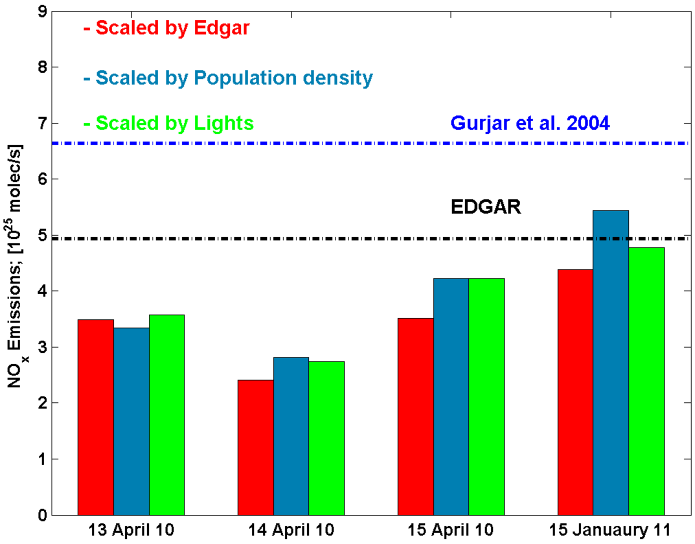

Fig. 2. *Comparison of the up-scaled NO_x emissions from the car MAX-DOAS measurements (using different proxies for the spatial distributions) and existing emission estimates.*

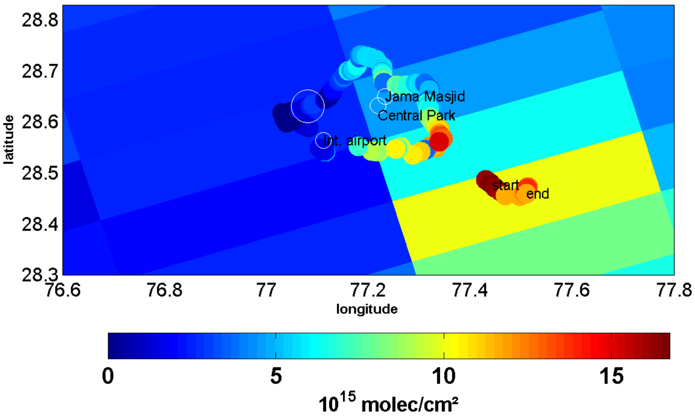

Fig. 3. *Comparison of the tropospheric NO_2 VCDs on 14 April 2010 measured from OMI and car MAX-DOAS. MAX-DOAS observations were carried out between 5:20 and 10:57 UT; OMI overpass was at 7:50 UT. The large circle indicates MAX-DOAS observations during OMI overpass*

The MAX-DOAS observations of the tropospheric NO_2 VCD were also used for validation of simultaneous satellite observations from the OMI instrument and a good agreement of the spatial patterns (see Figure 3) was found. OMI data tend to underestimate the tropospheric NO_2 VCDs in regions with high pollution levels, and tend to overestimate the tropospheric NO_2 VCDs in cleaner areas. These findings might indicate possible discrepancies between the true vertical NO_2 profiles and the profile assumptions in the OMI satellite retrieval.

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Impact of Urban Parameterization on High Resolution Meteorological and Air Quality Simulations with the GEM/LAM-AQ Model

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Introduction

In meso-gamma scale simulations of atmospheric processes the differences between rural and urban areas indicate the need for using urban parameterizations. The aim of the study was to assess the impact of urban cover on the high-resolution semi-operational meteorological and air quality forecast calculated with the GEM/LAM-AQ model (http://www.EcoForecast.eu).

The forecasting system is based on the GEM-AQ model (*Kaminski et al., 2008*). GEM-AQ is a comprehensive chemical weather model in which air quality processes (chemistry and aerosols), tropospheric and stratospheric chemistry are implemented on-line in the operational weather prediction model, the Global Environmental Multiscale (GEM) model, developed at Environment Canada. The regional forecast is computed on a global variable grid with the uniform resolution of 25 km (0.22 deg) over Europe. Nested high–resolution forecast is calculated on a 100 by100 grid with the resolution of 0.0625 deg and the time step of 120 s.

Urban cover description

To represent urban effects the TEB (Town Energy Balance) parameterization (*Masson, 2000*) implemented in the GEM/LAM model (*Lemonsu et al., 2008*) was used.

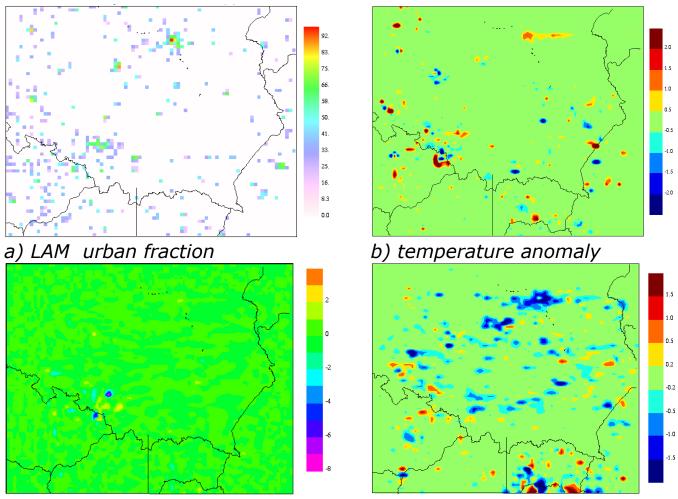
TEB parameterization distinguishes twelve categories of urban morphology (Table.1). In this study, due to relatively coarse resolution, the structure of the towns was described in a simplified way - only three urban cover categories were selected – representing city centre, middle suburbs and outer suburbs. The urban cover layers were constructed based on a fraction of towns in a grid cell. For most urban sites in the domain the fraction is ~30%. Two different datasets were prepared (Table.1).

***Table.1** Urban cover categories in TEB scheme – default average building height and anthropogenic heat flux. UF1/UF2 - two alternative approaches to describe urban cover*

No	TEB urban cover	Build. height	Anth. heat	UF-1 %	UF-2 %
1	High buildings	39	30		
2	**Mid-high buildings**	25	30		**>=35**
3	**Low buildings**	**13**	**30**	**>= 50**	
4	**Very low buildings**	8	30		**[5 , 35]**
5	Industrial areas	8	50		
6	**Sparse buildings**	**12**	**15**	**[10 ,50)**	
7	Roads and parkings	5	30		
8	Road borders	5	30		
9	High-density suburbs	5	15		
10	Mid-density suburbs	5	15		
11	**Low-density suburbs**	8	15		**< 5**
12	**Mix built / nature**	**8**	**0**	**< 10**	

Results

Three one-day cases representing different meteorological condition were selected: 6 of November 2010 (frontal passage), 3 of January 2011 (low wind, clear sky conditions, cold air mass) and 29 of March 2011 (moderate wind and cloudiness).



a) LAM urban fraction　*b) temperature anomaly*　*d) NO_2 concentration anomaly*　*c) wind speed anomaly*

***Figure.1** Differences between modelled temperature, wind speed and NO2 concentrations between "urban" and "non-urban" scenario for 3 January 2011*

Positive temperature anomaly over larger cities was reproduced in all modeled cases, however, the intensity of the UHI effect strongly depended on meteorological situation (wind speed and cloudiness) and the urban cover type. Anomaly of NO_2 concentrations were most significant over cities characterized with high NO_x emission. In most cases results calculated with urban parameterization taken into account showed the decrease of NO_2 concentrations most probably due to enhanced mixing (UHI) (Figure.1). Modelling results were compared against measurement from the air-quality monitoring urban stations.

Conclusions

The GEM/LAM-AQ model was exercised in high resolution configuration with urban parameterization taken into account. Although the urban structure representation was very simple the model response was correct in terms of magnitude of the anomalies between "urban" and "non-urban" scenarios and the relation to meteorological situation. The differences between the two alternative surface description approaches were relative small.

Preliminary analysis of the differences in modelled pollutants concentration fields between "urban" and "non-urban" scenarios indicate the importance of proper description of urban areas for high resolution air quality simulations.

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Air Quality Forecast Study with Enviro-HIRLAM in Istanbul

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Introduction

The following study results from a partnership between KNMI (Royal Netherlands Meteorological Institute) and ITU (Istanbul Technical University). Here we report our preliminary results of the ongoing research for the modeling of an episode period in Istanbul, which was submitted to NATO ITM 2010, Turin (Toros *et al., 2010*). In the first phase of the study, predictions of meteorological variables during episode period were obtained. The second phase of this collaboration is to study chemical weather forecasting for this episode period using Enviro-Hirlam.

Air Quality Levels and Episodes in Istanbul

Air quality levels in the urban area of megacities are a serious issue which usually depends on some meteorological condition. The strategy of new generation integrated Meso-Meteorological and Atmospheric Chemical Transport Model systems suggest considering the urban air quality as a combination and integration, at least, of the following factors: air pollution, meteorological/ climatic conditions, and population exposure (*Baklanov, 2008*). Chemical weather forecasts of high quality will be highly valuable. For this purposes we considered an investigation of air quality in Istanbul.

Istanbul is one of the megacities in the world with more than 13 million inhabitants.

The city (41^{0}N, 29^{0}E) is located on both continents, Asia and Europe with a total area about 5400 km^2.

Istanbul has experienced serious air quality problem in the past due to the poor quality coal usage for domestic heating and industry. Two pollutants were of major concern in 1980s. They were Total Suspended Particulates and SO_2 at those years. Following fuel switching in the city in the beginning of 1990s, SO_2 levels were decreased significantly. However, PM10 and NOx concentrations were increased in the whole city due to increasing number of the motor vehicles and uncontrolled industrial emissions.

Selection of Episode

An example for the air quality levels in the urban area of Istanbul is the time series of the daily and 3 day moving average PM10 concentrations for 10 urban air quality monitoring station. As can be seen in Fig. 1, there are several episodes in this one year period. The first episode starts in beginning of February, second beginning of March and third episode is started of late November 2009. The third episode is discussed here in more detail. The intention is to apply the model to similar episodic events in Istanbul as case studies. An anticyclonic high pressure prevailed over Istanbul and surrounding region that leads to low wind speeds and surface inversions during 18-20 November 2009.

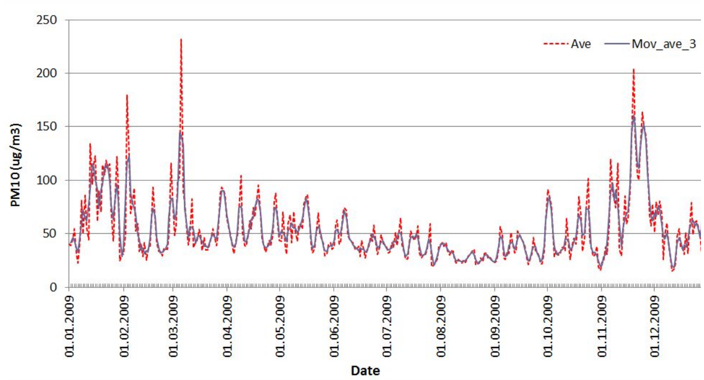

Figure 1. Daily and 3 day moving average PM10 values of 10 monitoring station, İstanbul.

These conditions caused poor air quality, especially in the Istanbul Metropolitan Area. The high PM10 concentrations during the episode considered here possibly originated from the local sources such as heating of residences in the beginning of winter season. The numerical weather forecasting model HIRLAM serves as a basic tool for weather forecasts in several European countries (http://www.knmi.nl/hirlam). Simulations were executed with version 7.2.1 of the HIRLAM model with 2.5 km horizontal resolutions. The simulations were able to predict the temperatures, wind speeds and relative humidity at near surface (Fig.2).

Discussion

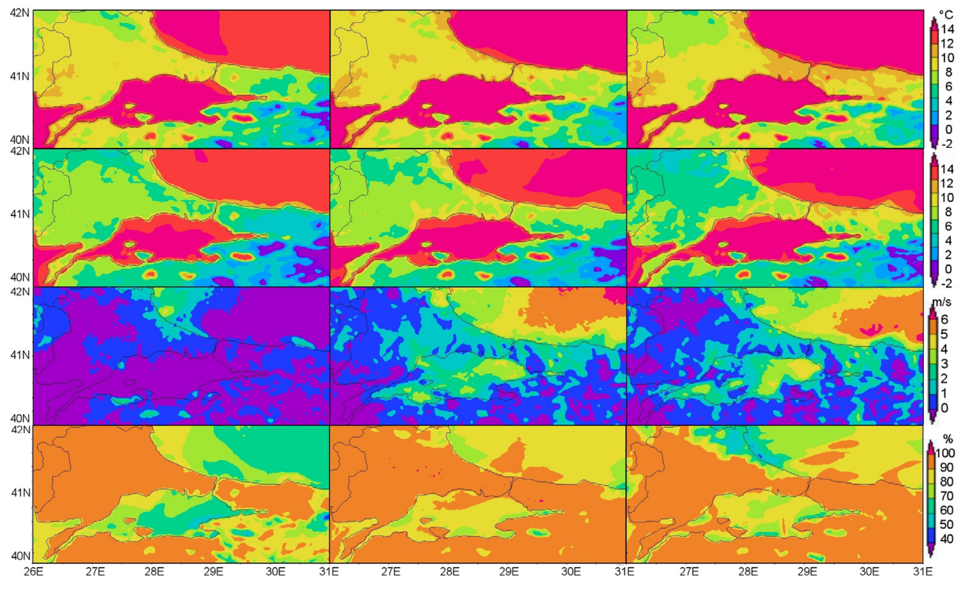

Figure 2. The 24-h forecast for max. temperature (1st panel), min. temperature (2nd panel), wind speed u10 (3rd panel) and relative humidity (4th panel) on 18 (left), 19 (centre) and 20 (right) Nov 2009.

Accuracy in forecasting air pollution levels depends critically on the ability of the numerical weather prediction models to compute the relevant meteorological parameters like pressure, temperature, wind speed and relative humidity. We have therefore tested the performance of the limited area weather forecasting model HIRLAM. This study showed that the 24 hours forecast from HIRLAM was able to forecast the high pressure, low wind speed, low temperature and high relative humidity.

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Mapping and Monitoring Megacities from Space

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Introduction

Urbanization is a global phenomenon. And the United Nations expect that almost all population growth for the world in the next thirty years will be concentrated in urban areas (*UN, 2009*). Explosive, often uncoordinated growth frequently leads to a lack of data and information to measure, monitor, and understand urban sprawl processes. The analysis of such changes has become an important use of multi-temporal remote sensing data and applications.

Study sites "Mega cities"

The United Nations define mega cities quantitatively as conurbation having more than 10 million inhabitants (*UN, 2009*). Mega cities are the largest category of urban agglomerations and thus they can serve as good predictors of future urbanization processes in incipient mega cities.

The Value of Remote Sensing

Earth observation is an independent, consistent, area-wide and up-to-date data source. The capabilities of various sensors reach far beyond the obvious benefits available at platforms like Google Earth or Bing. They provide reflective responses all along the electromagnetic spectrum which enables detection of objects or patterns on the earth's surface and their condition: The sensors cover many spatio-temporal dimensions, with a flexible repetition rate and in various scales ranging from spatially detailed analyses on single buildings or building block level to global studies on continental scale.

In combination with widely automated methods of data processing and image analysis, urban remote sensing provides multiple options to support decision makers such as resource managers, planners, environmentalists, economists, ecologists and politicians with accurate and up-to-date geoinformation.

In this study time-series data from the Landsat sensors as well as the TerraSAR-X satellite allow monitoring of cities for almost 40 years on a regional scale. Object-oriented classification algorithms facilitate the derivation of urban footprints from the optical Landsat data (*Taubenböck et al., 2009*). A pixel-based classification algorithm extracts urban footprints from the radar data of TerraSAR-X (*Esch et al., 2010*). The urban footprint is an abstract approximation of the particular city. Accuracy assessment with high detailed 3-D city models highlights that the urban footprint is closely related to the man-made environment of cities. Results show about 80 % correlation (*Taubenböck et al., 2011*).

Figure 1 illustrates one result of spatial megacity (Manila, Philippines) growth from 1975 until 2010. Using a pixel-based post-classification change detection, spatial urban growth can be identified. It enables to detect the spatial

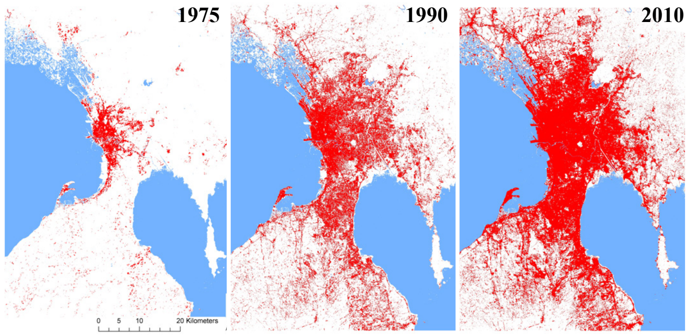

Figure 1. *Spatial growth at mega city Manila, Philippines.*

dimension of sprawl and the dynamics in dependence of time. Beyond that, processes such as redensification, leap frog development as well as patterns of growth such as axial, mono-or polycentric structures or satellite town evolution can be analysed.

The result of change detection is shown for the example of mega city Istanbul, Turkey. Figure 2 visualizes the growth of the metropolitan area along the Marmara Sea in four time steps since 1975.

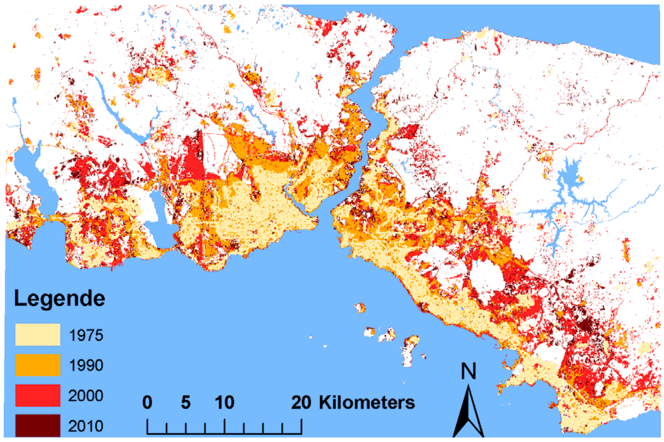

Figure 2. *Change detection for mega city Istanbul, Turkey.*

Critical in the description, analysis, and modelling of urban form and its changes are spatial metrics. Methods such as landscape metrics, gradient analysis or zonal statistics allow quantifying the spatial patterns (*Taubenböck et al., 2009*). With the consistent data from remote sensing cross-city comparisons as well as comparisons over time become possible.

Outlook

The constantly increasing availability and accessibility of modern remote sensing technologies provides new opportunities. The German Aerospace Center (DLR) intends to provide as one example a consistent multi-temporal change detection product on urban footprint level since the 1970s for all current 27 mega cities of the world. Beyond that the German TanDEM-X mission will provide a global coverage of TerraSAR-X stripmap data. With it, DLR aims at classifying the current global urban footprint.

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New Southern African Supersite for Atmospheric Observations

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Megacities are an increasing source of pollution due to migration to urban areas. This is more pronounced in developing countries, where economical means for proper regional area planning are limited. Due to uncontrolled migration, new informal settlements are often established around the formal perimeter of cities. This is also the case in South Africa, where the Gauteng metropolitan conurbation (Johannesburg, Pretoria and the associated greater metropolitan areas) continuously grow (currently already more than10 million people). Apart from its physical size, this conurbation is also the largest economical centre in Africa.

To study the global and regional effects of the Gauteng conurbation out-plume, a new comprehensive measurement station was started (*Laakso et al., 2008, Vakkari et al., 2011*) approximately 100 km west of Johannesburg in May 2010. The Welgegund measurement site (http://www.welgegund.org) is situated in a grazed savannah-grassland (Figure 1), with very little local pollution sources.

***Figure 1.** Welgegund measurement station during the rain season (October- April).*

However, the area is regionally strongly impacted by the plumes from the Gauteng metropolitan conurbation, as well as the other important industrialized areas of the South African interior (e.g. Vereeniging, Secunda and other industrialized Mpumalanga) (Figure 2). The site also receives air masses from background areas with no major industrial developments due to a clean sector to the west.

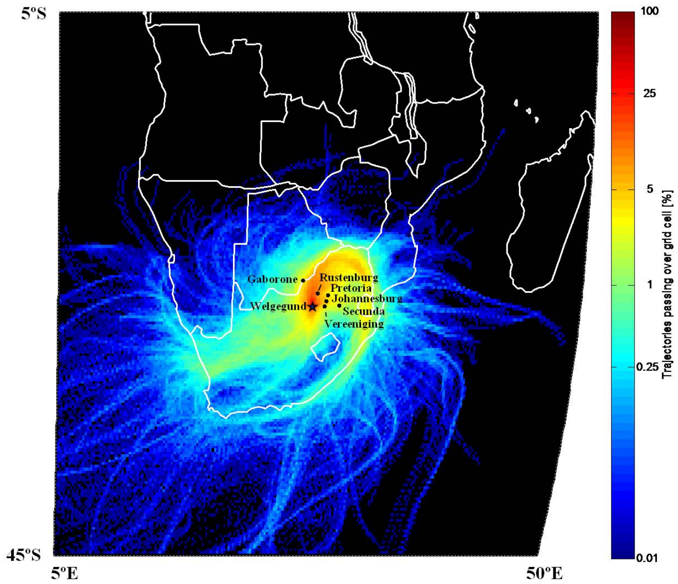

***Figure 2.** Origin of air masses at Welgegund measurement site based on two years of hourly HYSPLIT back-trajectories.*

The continuous measurements currently conducted at Welgegund include:

- Trace gases – SO_2, CO, NO_x, O_3 and VOC's
- Aerosol properties – air ion size distributions 0.4-40 nm, aerosol particle size distribution 10-840 nm, total PM_1, black carbon, 3-wl aerosol scattering, aerosol chemical composition by online Aerosol Mass Spectrometer and some off-line aerosol composition measurements
- Solar radiation – direct and reflected PPFD (Photosynthetic Photon Flux Density) and global radiation, net radiation
- Meteorology – precipitation, wind speed and direction, temperature at different heights and relative humidity
- Ecosystem – sensible and latent heat fluxes, CO_2 flux, soil temperature and moisture at different depths, soil heat flux

The first year of measurements revealed that the site selection (physical positioning) was scientifically sound, i.e. capturing the environmental impacts of the Gauteng metropolitan conurbation, as well as most of the other important industrialized areas of the South African interior.

During the prevailing easterly (Gauteng metropolitan conurbation impacts) and northerly winds (western Bushveld Igneous Complex impacts), concentration of particulates and trace gases reach very high values (e.g. O_3 above 95 ppb), capable of affecting radiative balance and causing damages on the regional ecosystem.

One of the current aims of the research is to determine the oxidation of the megacity plume. Another research focus is the validation of regional water balance models, which almost completely lack continuous boundary layer measurements of water exchange.

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Air Pollution in and around the South African megacity Johannesburg

Johannesburg is the largest city in South Africa with a population of approximately 3.8 million and increasing. This leads to an increase in anthropogenic emission sources, therefore posing a significant threat to human health, property and environment. Due to its remote location within the southern hemisphere, high altitudes and direct influences of surrounding industrial activities, Johannesburg holds a particular significance to photochemical modelling. The primary aim of this investigation is to use a box model with detailed gas-phase chemistry, along with new measurements of trace gases made at several locations in and around the city, to investigate the impact of surrounding industrial activities on the tropospheric photochemistry of Johannesburg. Model calculations are performed with the chemistry box model MECCA (Module Effective Calculating the Chemistry of the Atmosphere) developed and used by the Max Planck Institute for Chemistry in Mainz, Germany.

Year of PhD Defence: ***2012***

*Sci. Advisers**:** Tim Butler, Mark Lawrence (Max-Planck Institute for Chemistry, Germany), Paul Buekes, Kobus Pienaar, Pieter van Zyl (Northwest Univ, Potchefstroom, South Africa)*

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NO_2 measurements in megacities

Multi-Axis-Differential Optical Absorption Spectroscopy is observing the scattered sunlight under various viewing directions. Mobile MAX-DOAS observations are conducted on circles around localized emission sources or even whole cities. These observations combined with meteorological information give us the possibility to estimate the total emission of trace gases like NO_2, HCHO or Glyoxal. The amounts of tropospheric trace gases and aerosols can be determined by mobile MAX-DOAS observations, which can be used to validate the satellite data.

Year of PhD Defence: ***2011***

Sci. Advisers: Ulrich Platt (Institute for Environmental Physics, Univ. of Heidelberg, Germany), Thomas Wagner, Steffen Beirle (Max-Planck Institute for Chemistry, Germany)

--- Daniel Kunkel ---

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Regional and global transport and deposition of pollutants from megacities worldwide

In global models megacities are represented as pollution point sources and detailed differences in the emissions distribution between individual megacities become small compared to the resolution applied. However, the regional and global impact of a single megacity depends strongly on the local meteorology which governs the transport and deposition of the megacity pollution plume. Using generic passive tracers with constant emission rates in an atmospheric chemistry global circulation model (EMAC) and applying metrics for transport and deposition allows a ranking of megacities in terms of their pollution potential. Aerosol and gas-phase passive tracers are used to characterize the pollution potential of each megacity and the impact on various land use types and on human populations. Transport into different atmospheric regimes, such as remote-low-level regions and the upper troposphere, is investigated, as well as the local build up of pollutants, and the distinction between dry and wet removal as components of the total local and remote deposition.

Year of PhD Defence: ***2012***

Sci. Advisers: Mark Lawrence, Stephan Borrmann (Max-Planck Inst. for Chemistry, Germany)

--- Meri Hannukainen ---

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Comparison between the AOD derived from a global climate model HadGEM2 and from satellite observations

Aerosol optical properties influence the radiative balance of atmosphere. Aerosol Optical Depth (AOD) can be measured accurately by ground based instruments. Resources for this kind of measurements are, however, limited. Satellites provide regular, low maintenance measurements with global coverage. Satellite instruments AATSR (Along Track Scanning Radiometer) and MODIS (Moderate Resolution Imaging Spectrometer) covering globe in 3-5 and 1-2 days, respectively, measure reflected radiation, from which AOD can be retrieved. In this study, retrieval methods and results are under continuous evaluation and improvement. AODs retrieved from two satellite-based instruments are compared with HadGEM2 climate model results. The accuracy of AOD products is evaluated using ground based measurement network AERONET (AErosol RObotic NETwork; provides sun photometer data at approx. 400 stations in 50 countries). Preliminary results showed that satellite retrieved AODs are generally similar as regard their magnitude and spatial distribution. Differences are observed e.g. over regions with high surface reflectance. Other differences over various surfaces and in different situations and seasons are also observed, this needs further investigation.

Year of PhD Defence: ***2013***

Sci. Adviser: Gerrit de Leeuw (Finish Meteorological Institute); Co-Advisers: Anu-Maija Sundström (Univ. of Helsinki), Edith Rodriguez, Pekka Kolmonen, Larissa Sogatcheva (FMI)

--- Monica Crippa ---

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Stationary and mobile measurements of the chemical composition, sources and aging of aerosol particles

Stationary and mobile measurements have been performed during two measurements field campaigns in the Paris region, in order to study aerosol particles chemical composition, their physical properties and sources. Several instruments were deployed during the measurements and two "high resolution time of flight aerosol mass spectrometers" (HR-TOF-AMS) were used to investigate the evolution of the chemical composition of aerosol particles, their size distribution and source apportionment. In order to identify the main sources which contribute to the atmospheric aerosol formation different source apportionment techniques can be applied. The combination of statistical models with high time resolution measurements performed with the AMS allows a more detailed source apportionment, with discrimination of many sources. Positive matrix factorization (PMF) has been used to characterize organic aerosol in terms of HOA (Hydrocarbon-like Organic Aerosol), OOA (Oxygenated Organic Aerosol), BBOA (Biomass Burning), and other local sources, such as cooking (COA).

Year of PhD defence: ***2012***

Supervisor: Prof. Urs Baltensperger (PSI);

Co-Supervisors: Prof. Ulrike Lohmann (ETH-Zurich), Dr. Andre Prevot (PSI)

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Characterisation of the cloud condensation nuclei properties of complex aerosols: from the smog chamber to the free troposphere

During the MEGAPOLI campaign (January-February 2010) in Paris (SIRTA site) a CCN counter (DMT) was operated parallel to a condensation particle counter in a SMPS (Scanning Mobility Particle Sizer) setup in order to measure at 10 different supersaturations (0.1-1%) the CCN number size distribution next to the total particle (CN) number size distribution from 10 to 440 nm. This measurement setup, combined with data inversion makes it possible to determine the number size distribution of CN and CCN at a defined supersaturation. These measurements contain useful information not only on the average hygroscopicity of the particles but also on the mixing state with respect to hygroscopicity of the aerosol population.

Year of PhD defence: ***2010***

Supervisor: Prof. Urs Baltensperger (PSI);

Co-Supervisors: Prof. Ulrike Lohmann (ETH-Zurich), Dr. Martin Gysel (PSI)

--- Marie Laborde ---

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Investigation of black carbon properties using a single particle soot photometer

The measurements undertaken during MEGAPOLI will be part of my thesis that aims at measuring black carbon at its different state of ageing. The goal during Megapoli was to study the mixing state of black carbon and its evolution in the urban outflow of the megacity Paris in summer (July 2009) and winter (Jan/Feb 2010). Our stationary measurements took place at the sub-urban background site in SIRTA where I measured using a single particle soot photometer (SP2). This instrument allows measuring the mass of black carbon in individual particles independently of the amount or of the type of coating. We can also retrieve the coating thickness and therefore the mixing state of each particle and relate it to air masses for example. Black carbon properties have been measured continuously during winter 2010; however, only the mass concentration can be retrieved from the summer campaign.

Year of PhD defence: ***2012***

Supervisor: Prof. Urs Baltensperger (PSI)

Co-Supervisors: Prof. Thomas Peter (ETH-Zurich), Dr. Martin Gysel (PSI)

--- Torsten Tritscher ---

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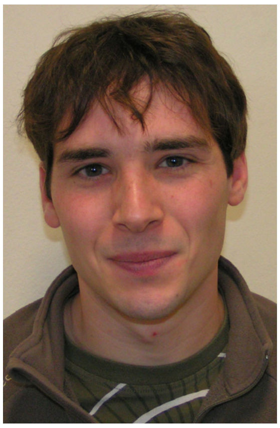
Hygroscopicity and volatility of aerosol particles

The measurements within MEGAPOLI are one part of my thesis about hygroscopicity and volatility of fresh and processed aerosols from different sources. The goal was to study the evolution of the chemical composition and physical properties of the aerosol in the urban outflow of the megacity Paris in summer (Jul 2009) and winter (Jan/Feb 2010). Our stationary measurements took place at the sub-urban background site in SIRTA and I focus here on the V/H-TDMA (volatility and hygroscopicity tandem differential mobility analyzer) measurements in the diameter range 35-265 nm. Volatility and hygroscopicity were continuously measured as volume fraction remaining (VFR) at 100°C and hygroscopic growth factor (GF) at 90% RH, respectively. From the GF scans (and sometimes also for volatility) we observed the mixing state of the aerosols.

Year of PhD defence: ***2011***

Supervisors: Prof. Urs Baltensperger (PSI), Dr. Ernest Weingartner (PSI)



--- Michoud Vincent---

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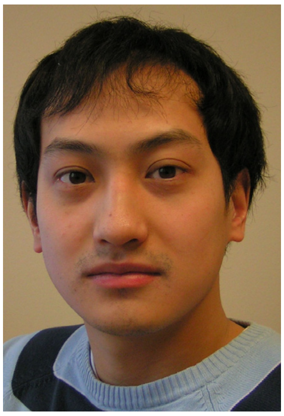
Megacities emission impact on nitrogen species cycle and fast gas chemistry

Within the FP7 EU MEGAPOLI project, two intensive field campaigns have been conducted in the Greater Paris region during summer 2009 and winter 2010 to evaluate the impact of Megacities on local and regional air quality. During these campaigns, particulate phase and gas-phase measurements have been performed. I was in charge of gas-phase measurements during MEGAPOLI campaigns, more precisely of nitrogen species (NOx, PAN, HONO) and Volatile Organic Compounds (VOCs). After the campaigns, the data obtained were validated. The aim of PhD is to study the radical chemistry as the driving force behind the oxidation of primary organic species into secondary pollutants. For that study, the photo-stationary state calculations are carried out for the radical and nitrous acid budget. This work will be completed by a 0D modelling study for the radical budget.

Year of PhD defence: ***2012***
Supervisor: Doussin Jean-François (CNRS-LISA)
Co-Adviser: Colomb Aurélie (CNRS-LaMP, Clermont Université, Université Blaise Pascal, Aubière, France)



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Simulation of Particulate Matter in grand agglomeration of Ile-De-France

The aim of this thesis is to improve the simulation of particulate matter and especially organic aerosol in the chemical transport model CHIMERE (http://euler.lmd.polytechnique.fr/chimere), and to apply the model to simulate sources and evolution of (organic) aerosol in a large megacity. The example chosen is the Paris agglomeration, where an intensive measurement campaign was held in July 2009 and winter 2010 in the frame of the FP7/MEGAPOLI project. To improve simulation especially of organic aerosol, the Volatility-basis-set (VBS) approach has been integrated into CHIMERE and evaluated with MEGAPOLI observations. The advection versus local origin of particulate matter is evaluated, so as the aerosol build-up in the Paris plume. The thesis is supported by French CIFRE grant attributed to LISA and ARIA.

Year of PhD defence: ***2011***
Supervisor: Matthias Beekmann (CNRS-LISA)
Co-Adviser: Armand Albergel (Aria Techonologies)

--- Guillaume Siour ---

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Modeling and multi scale impact assessment of European megacities

The main objective is to study relationship between the city-structure, air quality and pollutant transport over the continent. The main focus is on the continental scale and the export of pollutants from the megacities. To characterize as accurately as possible the composition and the intensity of the plumes exported by a megacity, a flux calculation was developed in the CHIMERE CTM, and the last version of the SAPRC chemical mechanism was implemented in order to obtain a more detailed VOC speciation during the plume aging. Moreover, a sensibility study about the evolution of European megacity emissions was conducted. Two options were taken into account: a densification of urban emissions inside megacity cores, and a "city-spreading scenario" simulating the increase of megacity emissions in the suburbs. In addition a 1-year (2005) simulation for the MEGAPOLI modeling exercise was carried out using TNO emissions and MATCH boundary conditions. It was done for the evaluation of integrated tools as well as model ensemble analysis.

Year of PhD defence: ***2011***
Supervisor: Isabelle Coll (CNRS-LISA)
Co-Advisers: Alain Dutot (CNRS-LISA), Augustin Colette and Bertrand Bessagnet (INERIS)

--- Zadie Stock ---

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Impact of megacities on regional and global atmospheric composition and climate

Quantifying the effects of megacities, cities with population greater than 10 million, on regional and global air quality is a key objective of the EU project MEGAPOLI. The UK Met Office global climate-chemistry model (Unified Model version 7.3) is used coupled to the UK Chemistry and Aerosols module (UKCA) at both typical climate resolution (1.875 x 1.25 degrees, 200 km) and at a higher resolution (40-60 km) to explore megacity effects across different scales. A number of global experiments are carried out for the year 2005 to identify sensitivity to changes in megacity emissions. A megacity mask, produced at 0.5x0.5degree resolution, is used to create both annihilation and redistribution scenarios, in which changes are made to the spatial distribution of megacity emissions. In these studies particular attention is paid to the importance of model and emission resolution for correct representation of megacity emissions.

Year of PhD defence: ***2012***
Supervisor: Prof. John Pyle, Centre for Atmospheric Science, University of Cambridge, UK
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Aerosol properties comparison between Paris and other megacities, using satellite and sun photometer measurements

One of the main objectives of the MEGAPOLI project is to assess impacts of megacities and large air-pollution hot-spots on local, regional and global air quality. In this study the effects of air pollution generated in different megacities have been analyzed. The aerosol distribution around Paris and other megacities like Mexico City, New York and New Delhi was compared using satellites and ground-based remote sensing measurements (during 2009). The satellite instruments used for this study were the Advanced Along Track Scanning Radiometer (AATSR), flying on ENVISAT and MODIS flying on Terra. Ground-based measurements were obtained from the AERONET sun photometer network. AATSR and MODIS provide information on the regional distribution of aerosol properties; AERONET provides information on local aerosol properties which is used to validate the satellite data, and to study gradients in along-wind situations. To calculate the Aerosol Optical Depth (AOD) and Ångström Exponent (AE), with the AATSR data, a combination of coarse and fine mode aerosol models is used. The comparison between AERONET, AATSR and MODIS shows good agreement but with some overestimation of AOD retrieved from AATSR.

Post Doctoral Research

Supervisor: Prof. Gerrit de Leeuw (Finnish Meteorological Institute)

--- Andreas Tack ---

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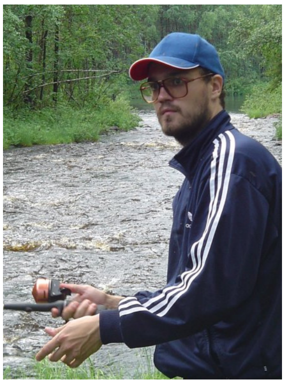
Mapping of urban topography with interferometric SAR

A cost efficient way to generate Digital Elevation Maps (DEM) is the use of space-borne Synthetic Aperture Radar (SAR). Large areas are covered and the data is freely available for scientific use. From the phase difference between a pair of SAR images information on the ground topography can be obtained. These images are subject to noise and phase ambiguities though. This can be overcome using multi-baseline interferometry from repeat-pass satellite observation. 13 ENVISAT-ASAR images are used to form 53 phase interferograms. From this information a height map of Paris will be derived, with resolution down to building-block level.

Year of BSc Defence: ***2011***

Supervisors: Prof. Jarkko Koskinen and Dr. Antti Hellsten (Finnish Meteorological Institute)



--- Jani Hakala ---

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Simulation of particulate matter in grand agglomeration of Ile-De-France

Aerosols are worth of studying because of their effect on climate and human health. In both cases, the most important qualities of aerosols are the size and the abundancy of the particles making the aerosol. With a Differential Mobilty Particle Sizer (DMPS) one can define an aerosol size distribution, which contains the information about these aerosol qualities. For the Megapoli campaign, a flow-switcing DMPS was built at Division of Atmospheric Sciences of University of Helsinki. The aim of building this instrument was to make a portable DMPS system with a performance similar to the twin-DMPS used in the SMEAR measuring stations in Finland. The flow- switching DMPS has proven to be a robust and low maintenance instrument to make reliable measurements of a particle size distribution in a size range of 6-800 nm.

Year of BSc Defence: ***2010***

Supervisors: Drs. Tuukka Petäjä and Pasi P. Aalto (Univ of Helsinki, Divis.of Atmos. Sciences)

--- Yulia Gavrilova ---

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Thermal and dynamical urban effects of Saint-Petersburg metropolitan area

The urban areas have significant influence on the meteorological processes and atmospheric flow, its turbulence regime, the microclimate, and, accordingly, modify the transport, dispersion, and deposition of atmospheric pollutions within these areas. In this study, the spatial and temporal variability of meteorological fields due to influence of the thermal and dynamical urban effects of St. Petersburg (Russia) urban area was evaluated using the Enviro-HIRLAM model (with horizontal resolution of 1.4 km). The selected case study is linked with winter period of 2009. Dependence of meteo.fields on temporal variability of meteorological variables in the lower surface layer (wind at 10 m and air temperature at 2 m) was estimated as a function of roughness, anthropogenic heat flux, and albedo. The differences between control vs. urbanized runs over the metropolitan area were: for wind speed - up to 2 m/s (max 2.9) and for air temperature - more than 1ºC (max 2.7). The simulation results were compared with observations at urban/ sub-urban synoptical stations within the metropolitan area. Results showed that urbanization can significantly improve the forecasting in urban areas, and combined urbanization effects have shown significant role of non-linear effects

Year of MSc Defence: ***2010***

Supervisors: Prof. Sergey Smyshlayev (Russian State Hydrometeorological University) and Dr. Alexander Mahura (Danish Meteorological Institute)

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Coming and Recent Presentations and Publications

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

- Schlünzen K.H., M. Haller (Eds) (**2011**): Evaluation of Integrated Tools. *MEGAPOLI Scientific Report 11-03, MEGAPOLI-29-REP-2011-03, 51p., http://megapoli.dmi.dk/publ/MEGAPOLI_sr11-03.pdf*
- Sofiev M., M. Prank, J. Kukkonen (Eds) (**2011**): Evaluation and Improvement of Regional Model Simulations for Megacity Plumes. *Deliverable D5.3, MEGAPOLI Scientific Report 11-04, MEGAPOLI-30-REP-2011-03, 88p.,* http://megapoli.dmi.dk/publ/MEGAPOLI_sr11-04.pdf
- Baltensperger U., Beekmann M., and the MEGAPOLI campaign team (**2011**): Source Apportion-ment of Major Urban Aerosol Components Including Primary and Secondary PM Sources. *Deliverable D3.2, MEGAPOLI Scientific Report 11-05, MEGAPOLI-31-REP-2011-05, 20p., (available at internal web-site);* http://megapoli.dmi.dk/publ/MEGAPOLI_sr11-05.pdf
- Grell, G., Baklanov, A. (**2011**): Integrated modeling for forecasting weather and air quality: A call for fully coupled approaches, *Atmospheric Environment, doi:10.1016/j.atmosenv.2011.01.017*
- Konovalov I.B., M. Beekmann, I.N. Kuznetsova, A. Yurova, and A. M. Zvyagintsev (**2011**): Atmospheric impacts of the 2010 Russian wildfires: integrating modelling and measurements of the extreme air pollution episode in the Moscow megacity region. *Atmos Chem Phys Discus., 11, 12141-12205*
- *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 MEGAPOLI Project results and findings:

- MUSCATEN et al. Summer School on "Integrated Modelling of Meteorological and Chemical Transport Processes / Impact of Chemical Weather on Numerical Weather Prediction and Climate Modelling"
  Odessa, Ukraine, 3-9 Jul 2011
  http://www.ysss.osenu.org.ua
- Urban Air Quality and Climate Change Workshop (UAQCC)
  Hamburg, Germany, 16-18 Aug 2011
  http://www.klimacampus.de/?id=1785
- European Meteorological Society (EMS-2011) Annual Meeting
  Berlin, Germany, 12–16 Sep 2011
  http://www.emetsoc.org/news_meetings/news_meetings.php
- Final MEGAPOLI Project Symposium (3rd Annual Meeting)
  Paris, France, 26-28 Sep 2011
  contact: Matthias Beekmann, CNRS-LISA (beekmann@lisa.univ-paris12.fr)
- 14th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes
  Kos Island, Greece, 2-6 Oct 2011
  http://www.harmo.org/harmo14
- 8th International Conference on Air Quality Science and Application
  Athens, Greece, 19-23 Mar 2012
  http://www.airqualityconference.org