The CityZen project
Bridging the scales with focus on megacities

Laurence Rouïl (INERIS), Michael Gauss (met.no)

and the CityZen Team

Michael Gauss, Markus Amann, Bertrand Bessagnet, John Burrows, Rita Cesari, Cathy Clerbaux, Stefano Decesari, Massimo D'Isidoro, Maria C. Facchini, Ahmed Fahmy, Ann M. Fjaeraa, Sandro Fuzzi, Evangelos Gerasopoulos, Claire Granier, Angelika Heil, Øystein Hov, Min Hu, Ivar S.A. Isaksen, Hermann Jakobs, Maria Kanakidou, Mehmet Karaca, Tayfun Kindap, Mustafa Kocak, Nilgun Kubilay, Zbigniew Klimont, Kathy Law, Alberto Maurizi,Frederik Meleux, Michael Memmesheimer, Nikos Mihalopoulos, Mihaela Mircea, Paul Monks, Agnes Nyiri, Jacques Pelon, Michael Petrakis, John Remedios, Andreas Richter, Laurence Rouil, Martin Schultz, Sjaak Slanina, Sverre Solberg, Frode Stordal, Francesco Tampieri, Leonor Tarrason, Kjetil Tørseth, Alper Unal, Christos Zerefos, Yuanhang Zhang

- *2007 was the first year in history when urban population was larger than rural population (UN)*

- *Increased anthropogenic emissions and urbanization have significant impacts on air pollution exposure in the hot spot areas and on a larger scale*

Project acronym: CityZen

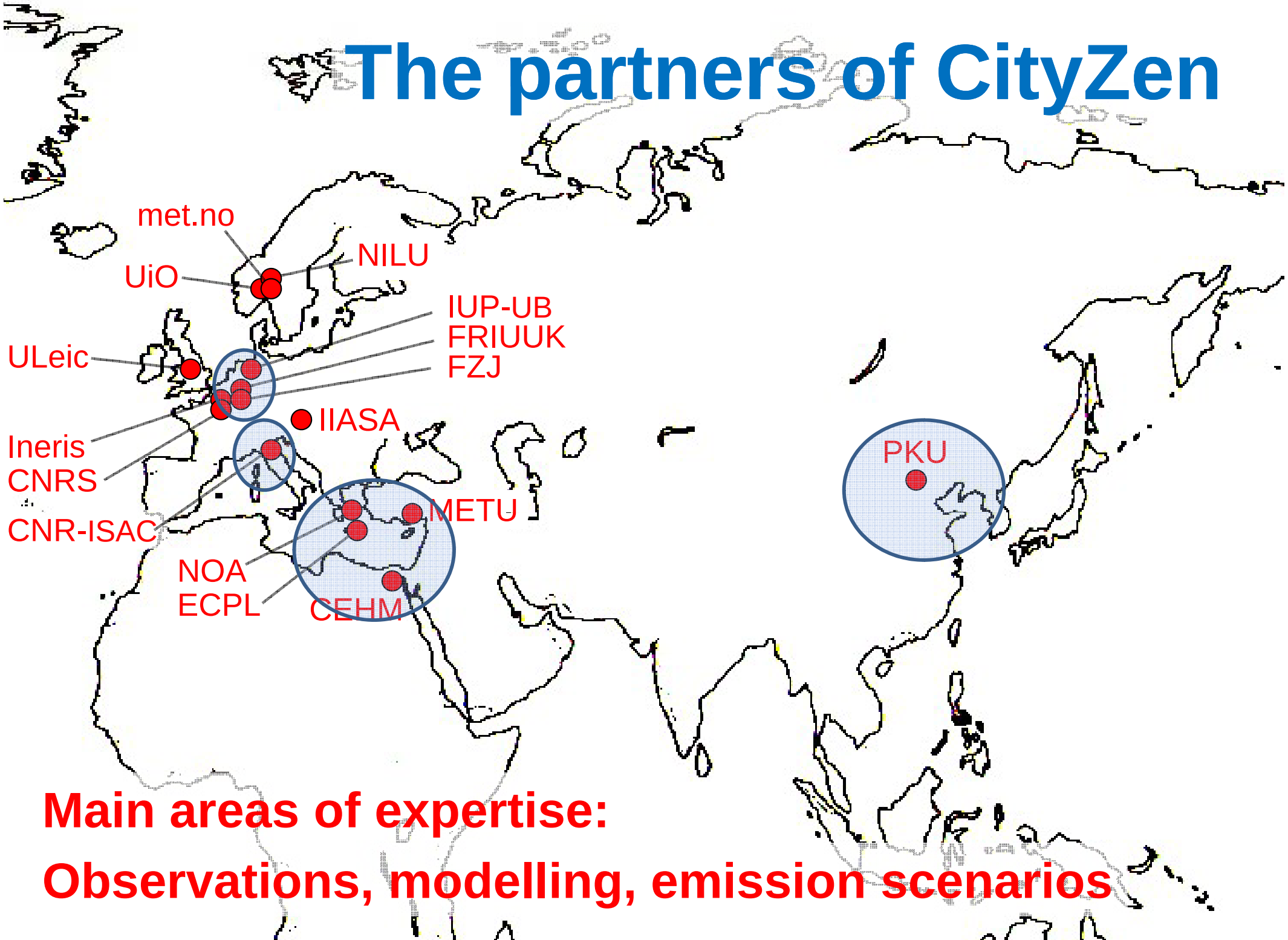
Project full title:
megaCITY - Zoom for the Environment

Total budget: ~ 4 m€

(FP7 medium-scale focused research project)

Duration: 3 years (start: September 2008)

The partners of CityZen



Main areas of expertise:

Observations, modelling, emission scenarios

The main objectives of CityZen (1/2)

- **Quantify and understand current air pollution in and around selected megacities/hot spot regions**
  - **distribution and evolution over time (past and future)**
  - **interaction across the different spatial scales**

- **Estimate how megacities/hot spots influence climate change**
  - **emissions of greenhouse gases, particles, precursors**
  - **Air pollution patterns**

- **Estimate how megacities are responding to climate forcing**
  - **Air pollution levels**
  - **chemical oxidation and biogenic emissions**

- **Development of tools to estimate interactions between different spatial scales combining modelling and observational data**

The main objectives of CityZen (2/2)

- **Estimate the impact of future emission changes**
  - **rapid growth in the population of megacities/hot spots**
  - **increasing background of pollutants**
  - **focus on ozone, particulate matter, and their precursors**

- **Study mitigation options**
  - **introduction of alternative fuels**
  - **different public transportation options**
  - **structural changes in population distribution**

- **Provide technical underpinning of policy work**
  - **both during and after the project has ended**

Main issues to describe the project :

- **Focus on four selected emission hot spots**

- BeNeLux and Ruhr area
- Po Valley
- Eastern-Mediterranean (Athens, İstanbul, Cairo, etc.)
- Pearl River Delta (Guangzhou, Shenzhen, etc.) + Hong Kong

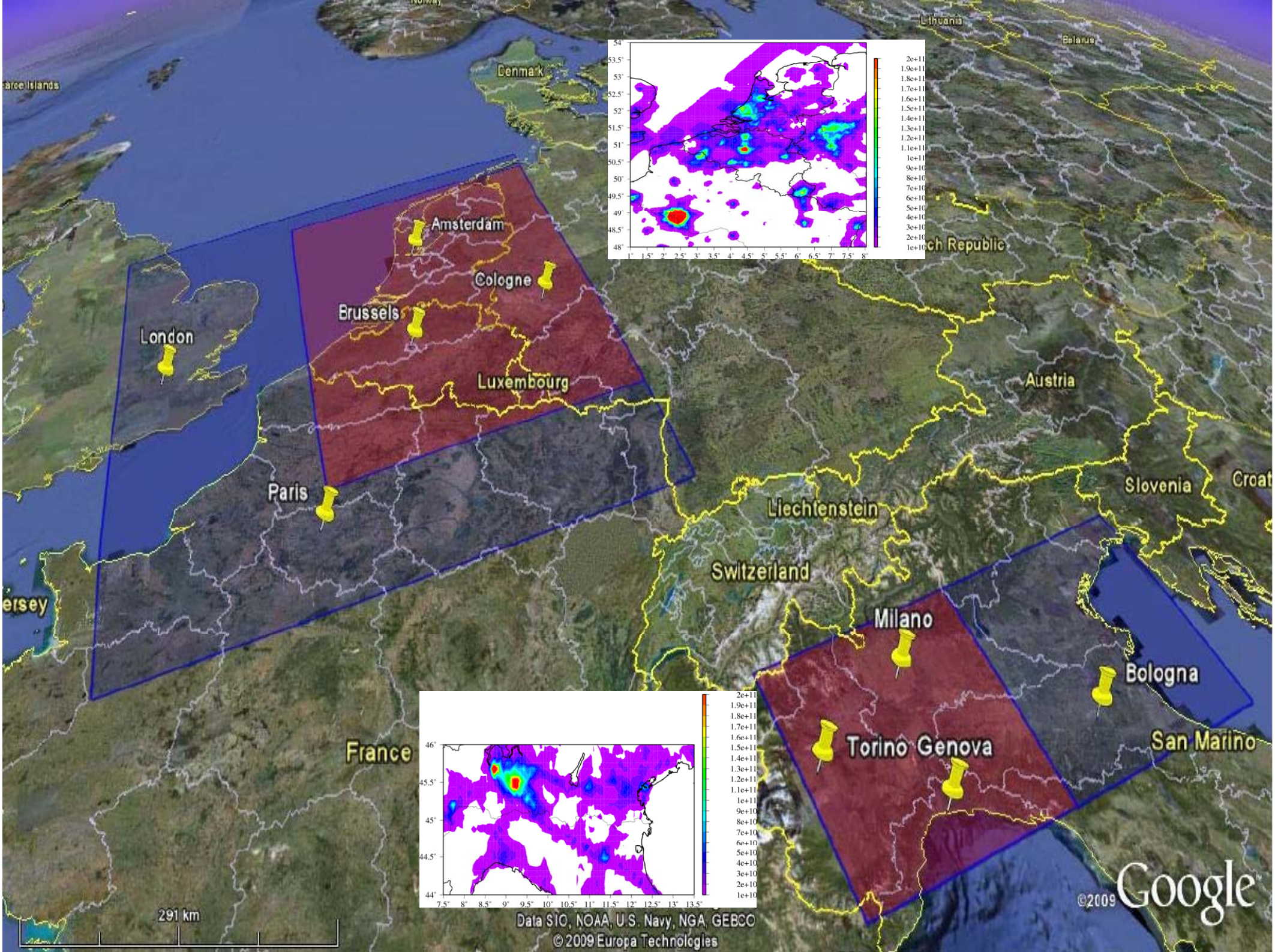
- **Accounting for interactions between spatial scales**

- **Feedbacks :** air pollution ←→ climate

- **Analysis of the current status (over the last decade) and investigations related to the future**

- **Case studies**

- extreme summer of 2003 (Western and Central Europe)
- extreme summer of 2007 (South- Eastern Europe)


Amsterdam
Cologne
Brussels
London
Luxembourg
Paris
Milano
Bologna
Torino
Genova
San Marino
Switzerland
Liechtenstein
Austria
Slovenia
France
Denmark
Lithuania
291 km
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2009 Europa Technologies
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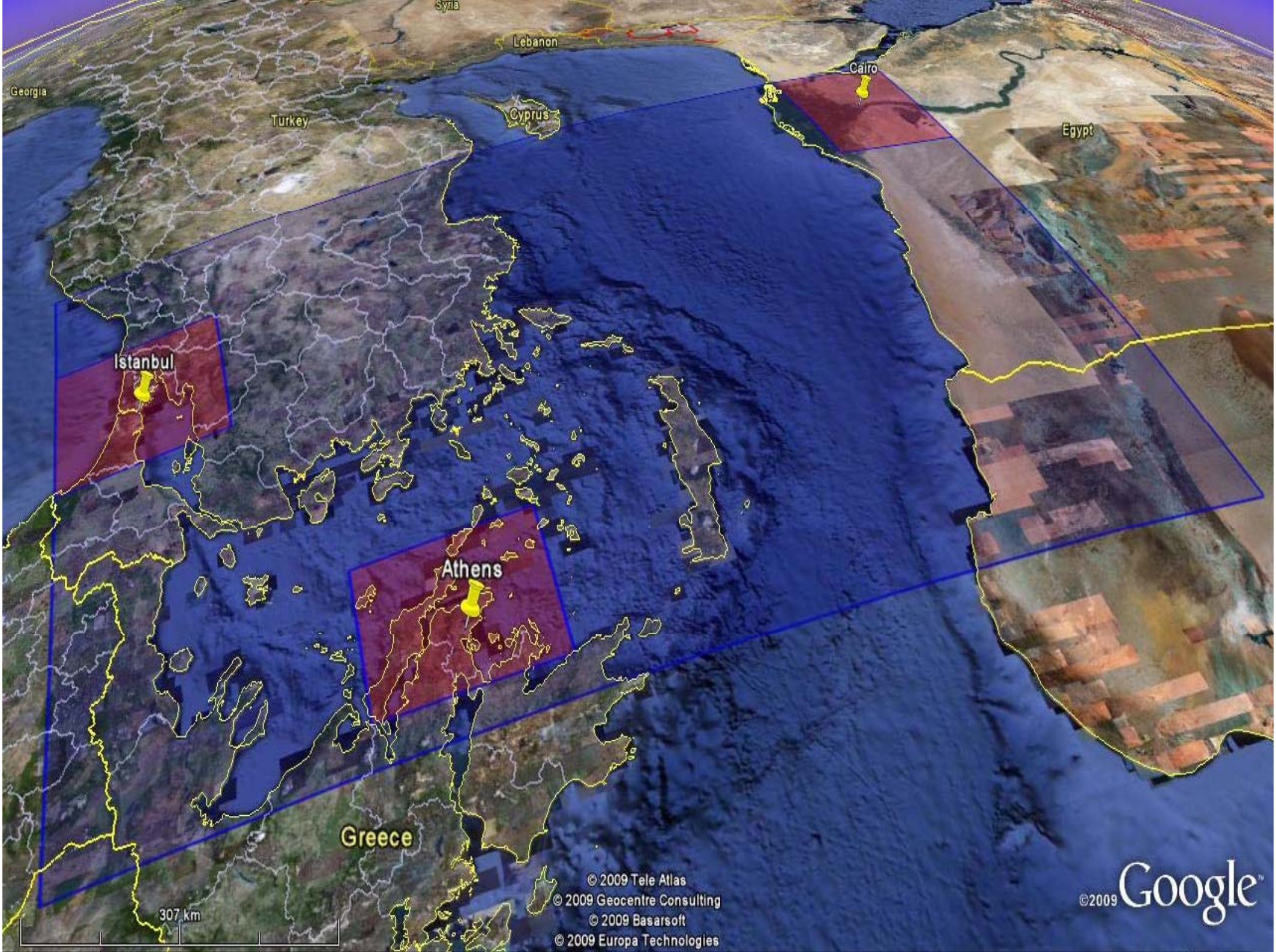
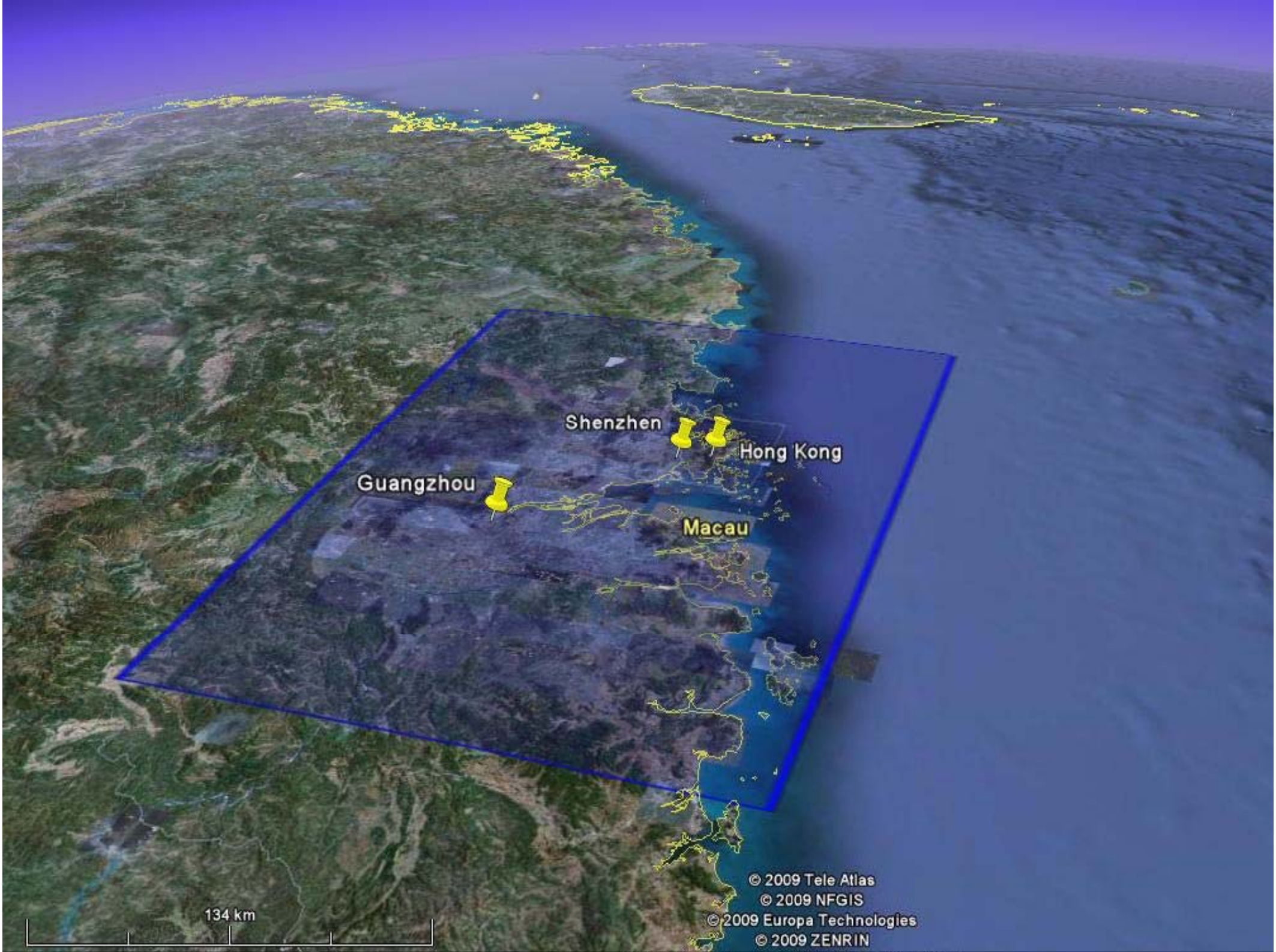
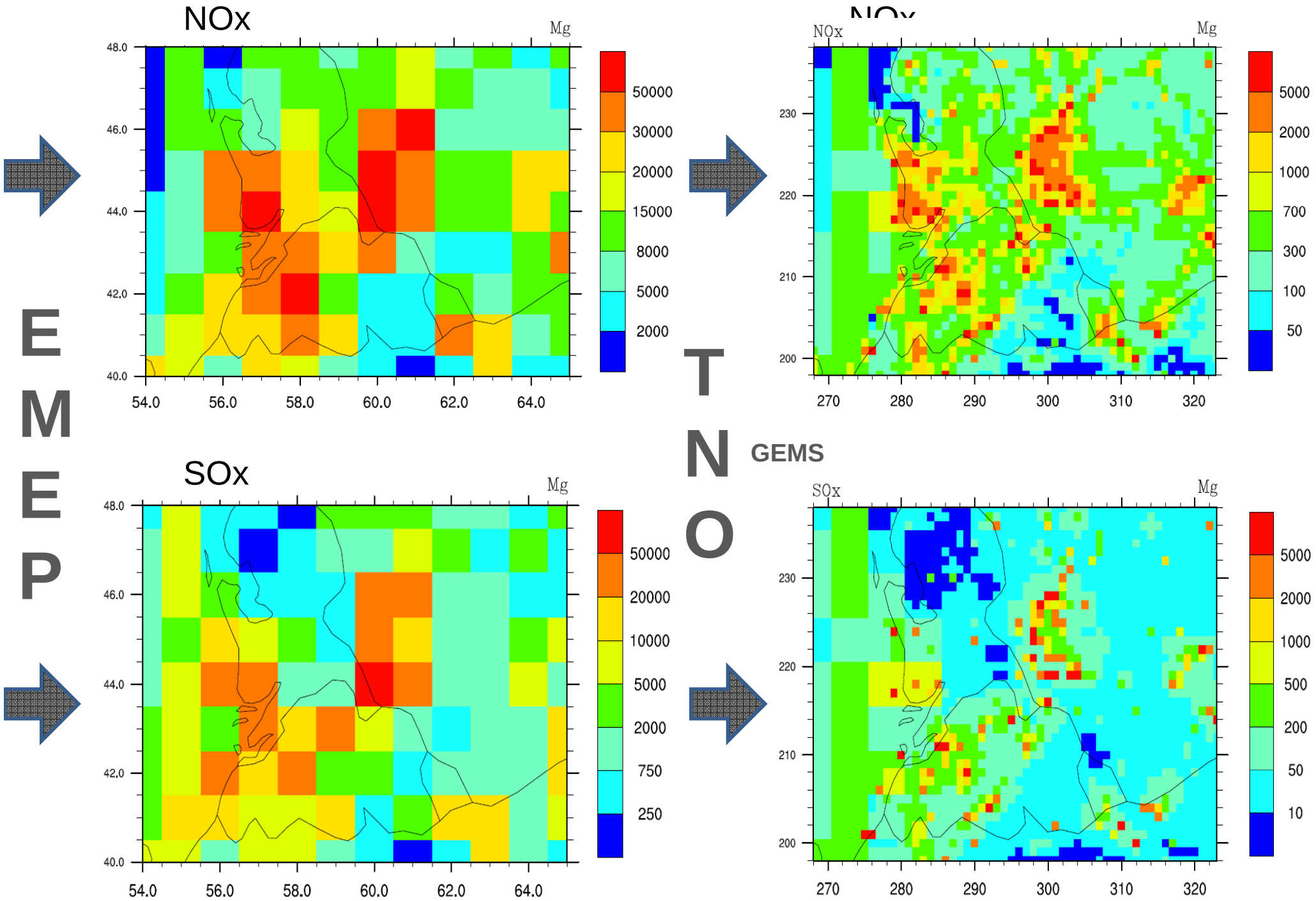

Syria
Lebanon
Cairo
Georgia
Turkey
Cyprus
Egypt
Istanbul
Athens
Greece
307 km
© 2009 Tele Atlas
© 2009 Geocentre Consulting
© 2009 Basarsoft
© 2009 Europa Technologies
©2009 Google


Shenzhen
Hong Kong
Guangzhou
Macau
134 km
© 2009 Tele Atlas
© 2009 NFGIS
© 2009 Europa Technologies
© 2009 ZENRIN

Methodology : emission inventories and projections

- 1998-2007 in Europe : EMEP data (50km*50km) spatially gridded using the TNO data set (10km*10km)
  Cooperation with the GMES atmospheric Service initiative (MACC)
- Projections for Europe : IIASA expertise

- 1998-2007 and projections outside Europe : a consolidated dataset built upon the databases used for developing scenarios for IPCC-AR5 : CNRS expertise + IIASA expertise
- + EDGAR 2005 database
  Cooperation with the Task Force on Hemispheric Transport (CLRTAP/EMEP program)


NOx
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From metno

Methodology : Participating models (i)

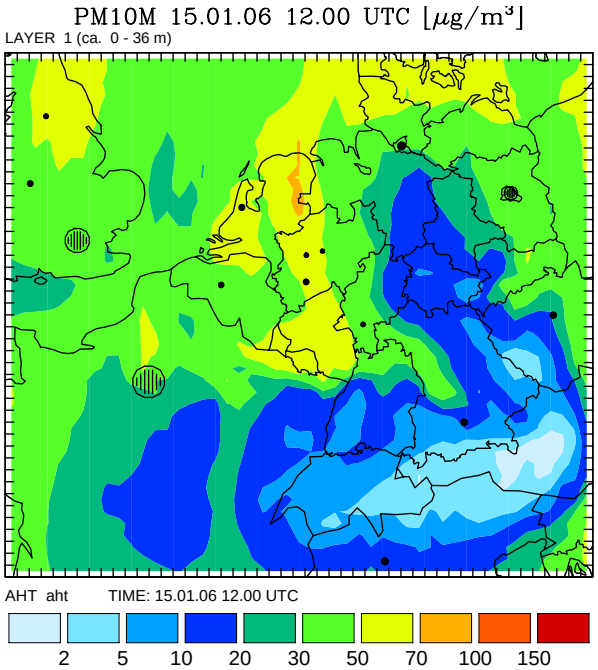
- Global scale:
  - MOZART, ECHAM5-HAMMOZ, EMEP, OsloCTM2, TM4-ECPL (1°x1°)
- Regional scale :
  - CHIMERE, EMEP, EURAD, Models-3/CMAQ (~0.5°x0.5°)
- Local scale :
  - CHIMERE, EMEP, EURAD, BOLCHEM , Models-3/CMAQ (~1x1 - 10x10 km^2 resolution)

Methodology : modelling exercises(ii)

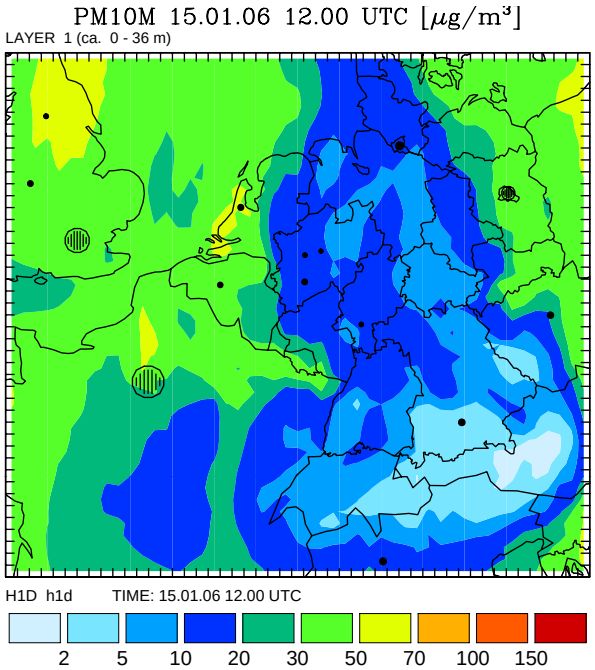
	Benelux small	Benelux Big	Po Valley small	Po Valley big	Eastern Mediterranean	Pearl river delta
10 years analysis: UiO, EMEP, CNRS, PKU , FZJ , FRIUUK	INERIS FRIUUK CNR EMEP UiO ECPL (tbc)	INERIS FRIUUK CNR EMEP UiO ECPL (tbc)	INERIS CNR EMEP UiO ECPL (tbc)	INERIS FRIUUK CNR EMEP UiO ECPL (tbc)	INERIS (tbc) FRIUUK (tbc) CNR (tbc) EMEP (tbc) ECPL	INERIS PKU (tbc)
Import/export budget: Switching off/on megacity emissions Evenly distributed emissions	same as above	same as above	same as above	same as above	same as above	same as above
Bridging methodology :	INERIS Zooming approach	INERIS Zooming approach	Tracer experiments	Tracer experiments		
Process analyses (BVOC, SOA)	Specific episodes	Specific episodes	BVOC	BVOC	Photochemistry SOA	

SPECIFIC EPISODES: PM10, Jan 15, 2006

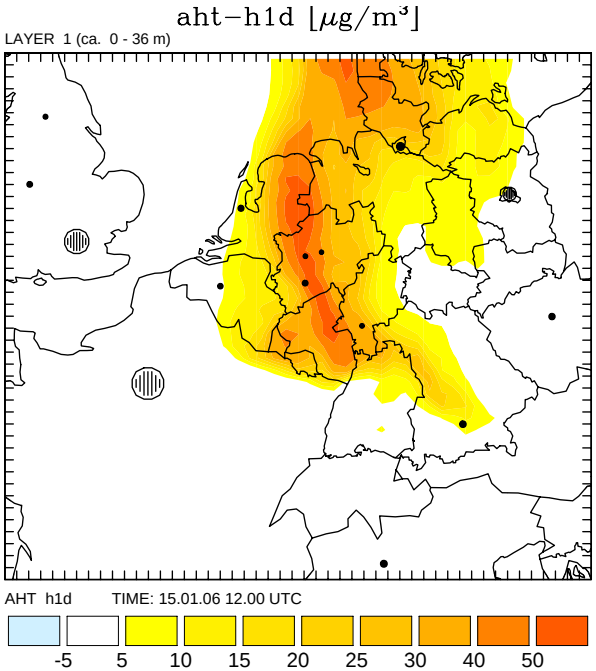
Base Case



Scenario: no Emi-GER



Base - noEmi-GER



Transport dominated episode over North-Rhine-Westphalia, PM10 concentrations in NRW mainly due to inflow from south

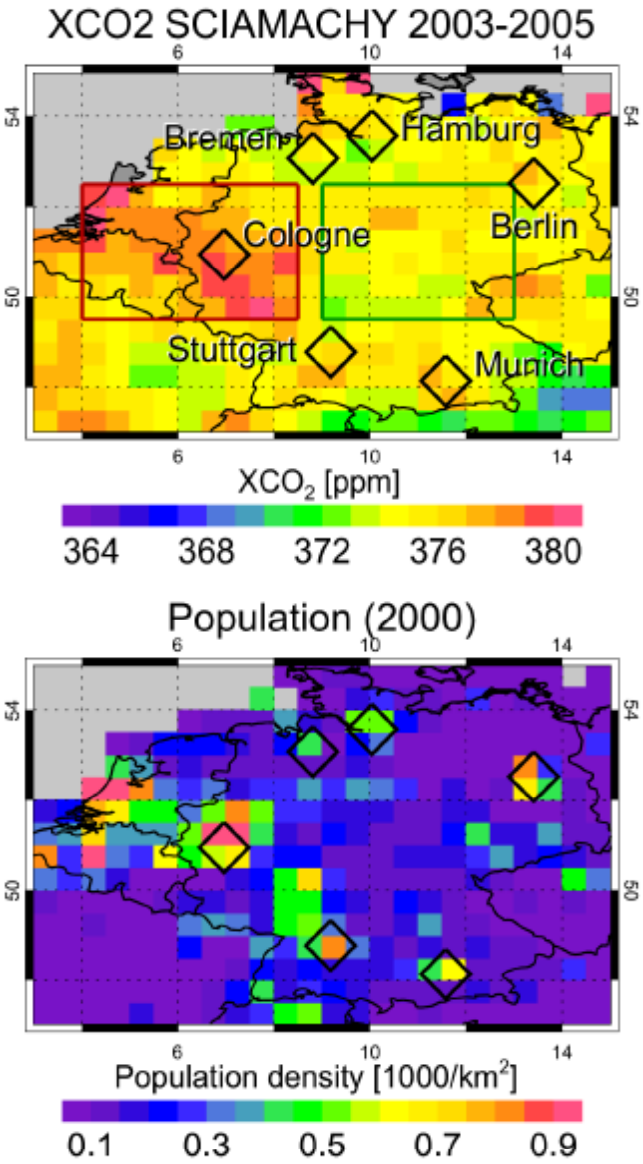
From FRIUUK -

Measurements in CityZen

- Satellite:
  - GOME, SCIAMACHY, GOME-2, OMI, ... : expertise from IUP-Univ bremen
  - IASI, ACE, CALIPSO : expertise from CNRS
- Ground-based:
  - Local expertise of the Cityzen partners in the four selected hotspot regions to get continuous measurement data and field campaign results
  - Official databases (cooperation with EEA, EMEP, WMO, MOZAIC/IAGOS, NILU...)

Greenhouse gases (GHG) from SCIAMACHY

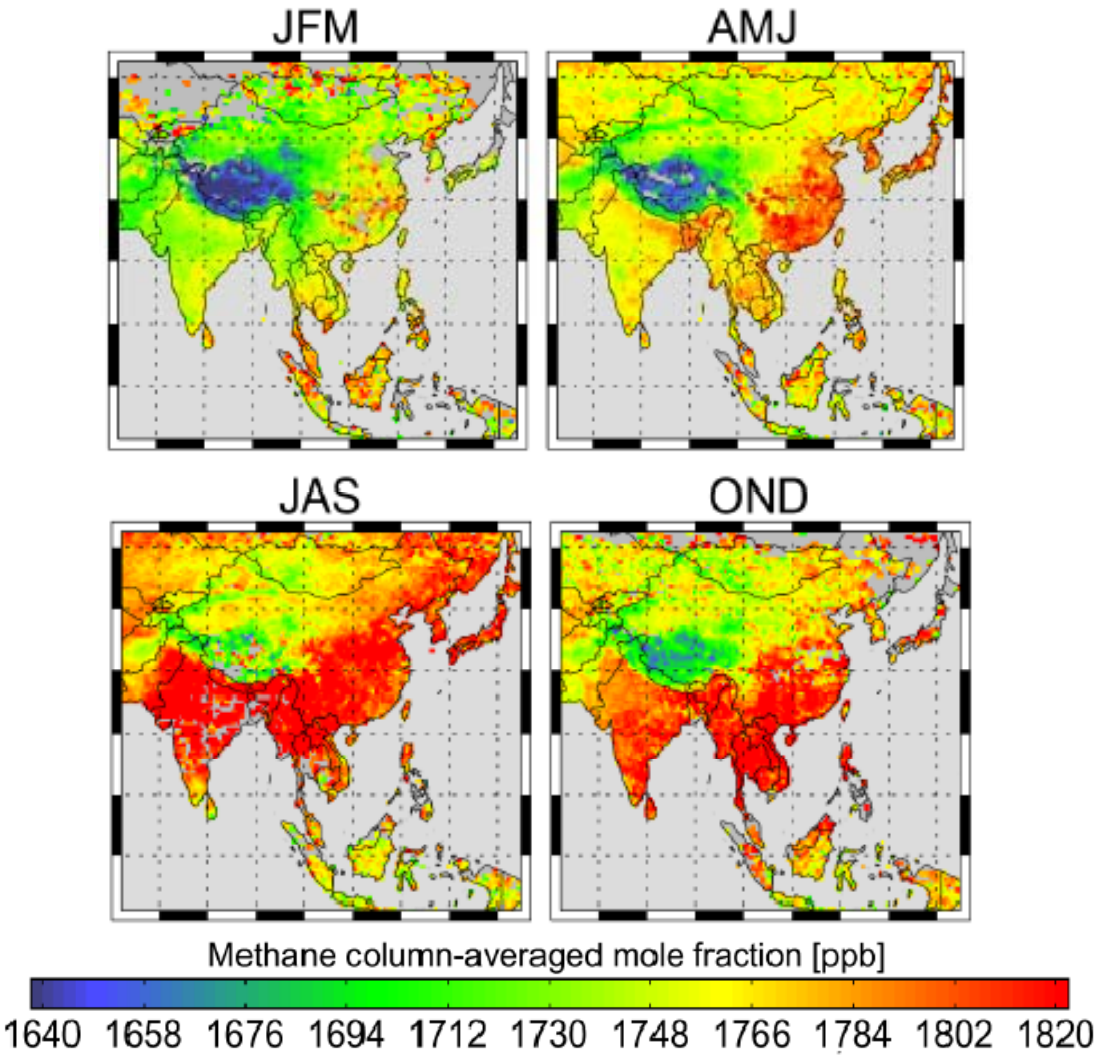
Carbon dioxide



Schneising et al., ACP, 2008

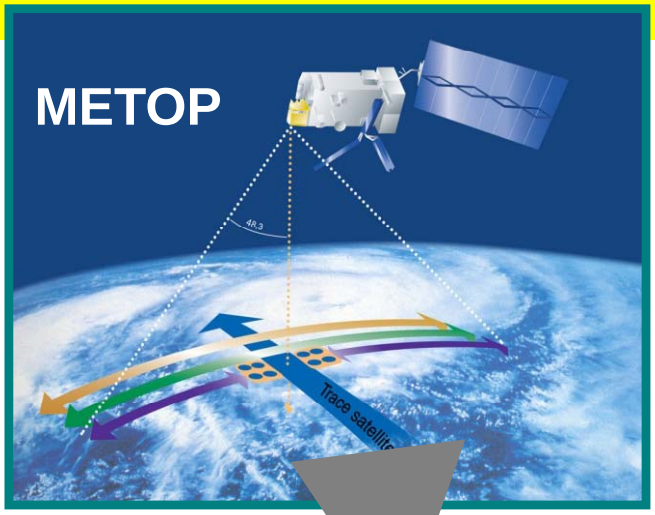
GHG from Univ. Bremen, IUP

Methane

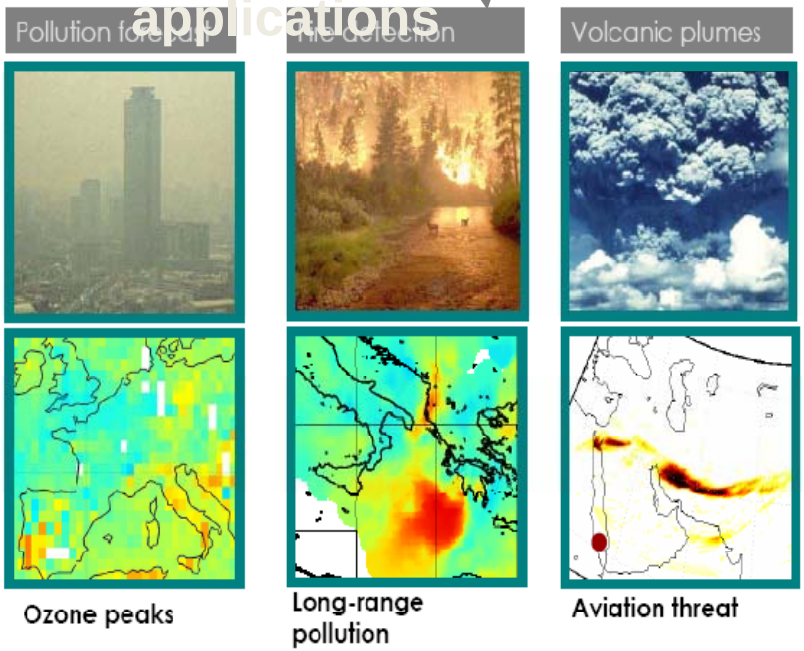


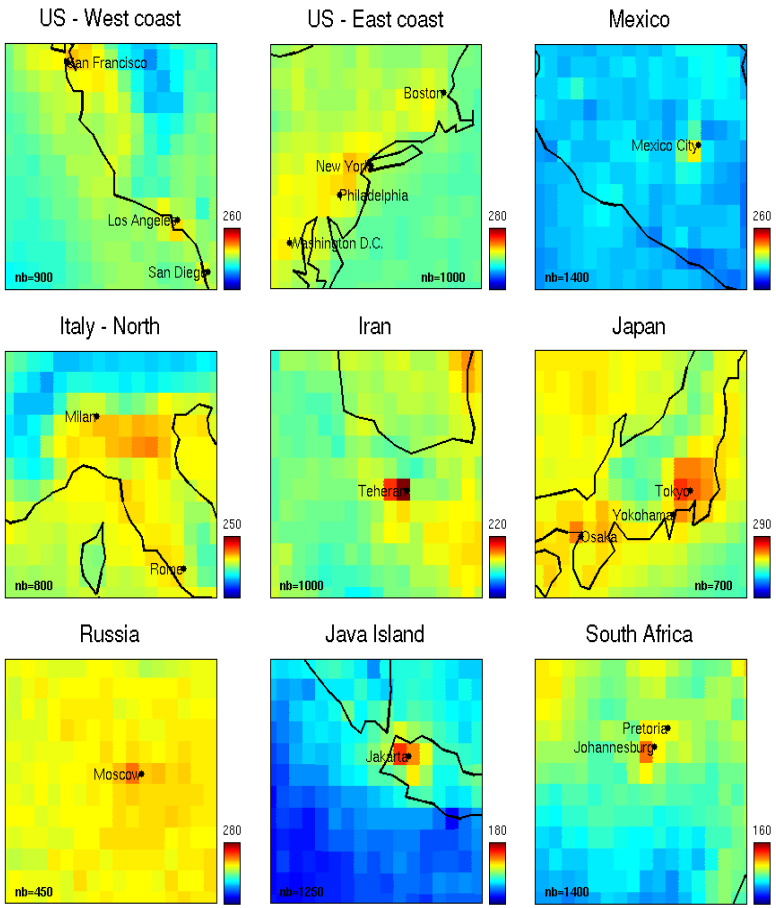
Schneising et al., ACP, 2009

Observation of ozone and CO at the city scale using the IASI satellite on board METOP (CNRS)



Operational applications



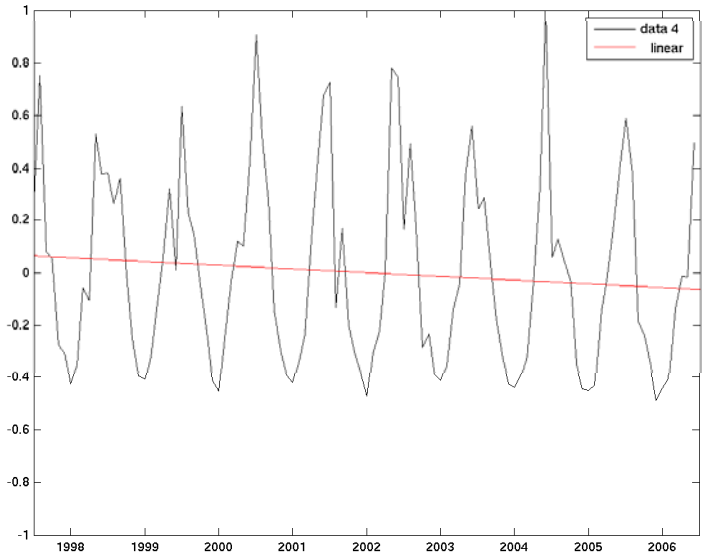


Clerbaux et al., GRL, 2008

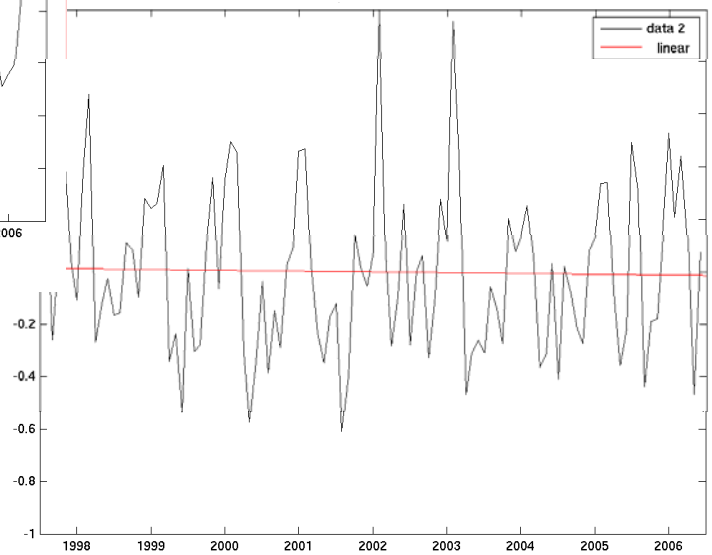
(CO Mopitt data, work in progress on IASI data)

In-situ observations : Just a warm-up…

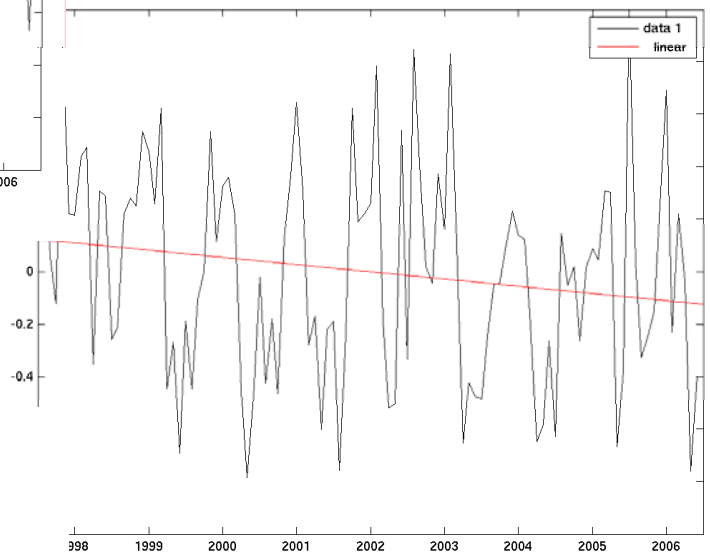
NOx (norm.)



particulate nitrate (norm.)

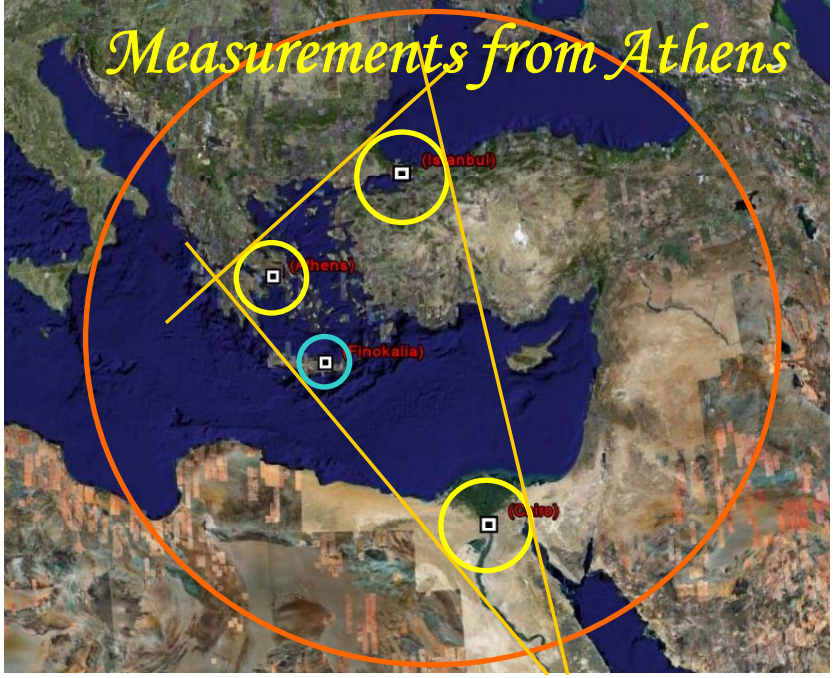


SO_4 (norm.)



Example: BeNeLux+Ruhr surface concentrations 1998-2006 (EMEP UM)

From metno -



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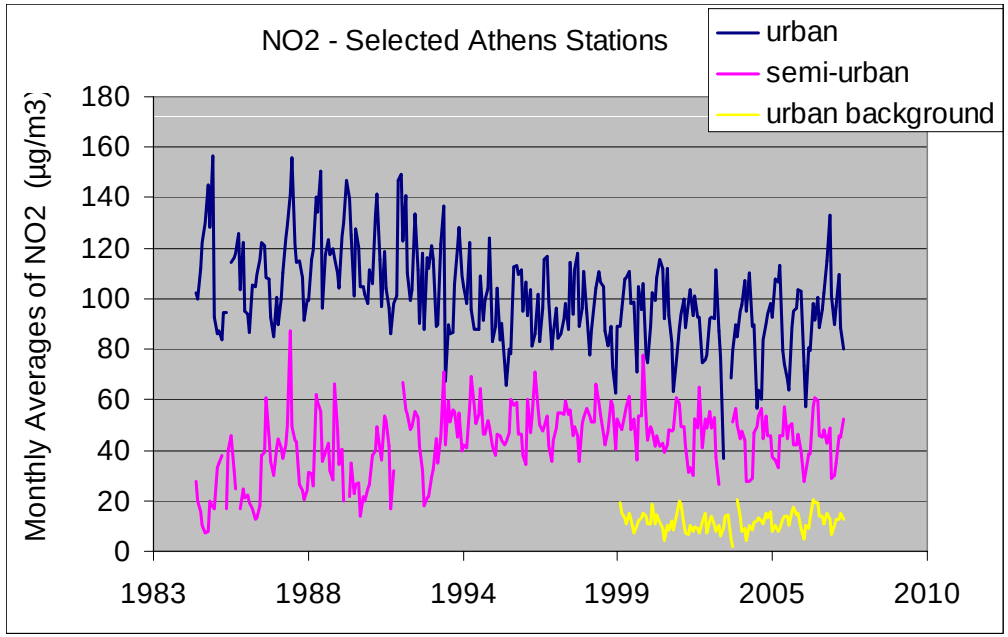
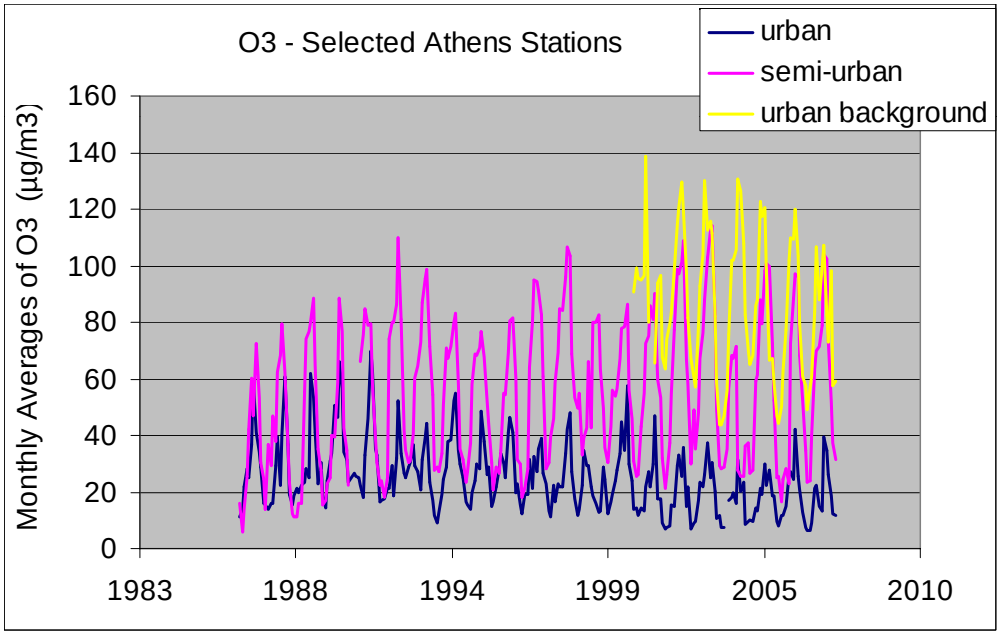
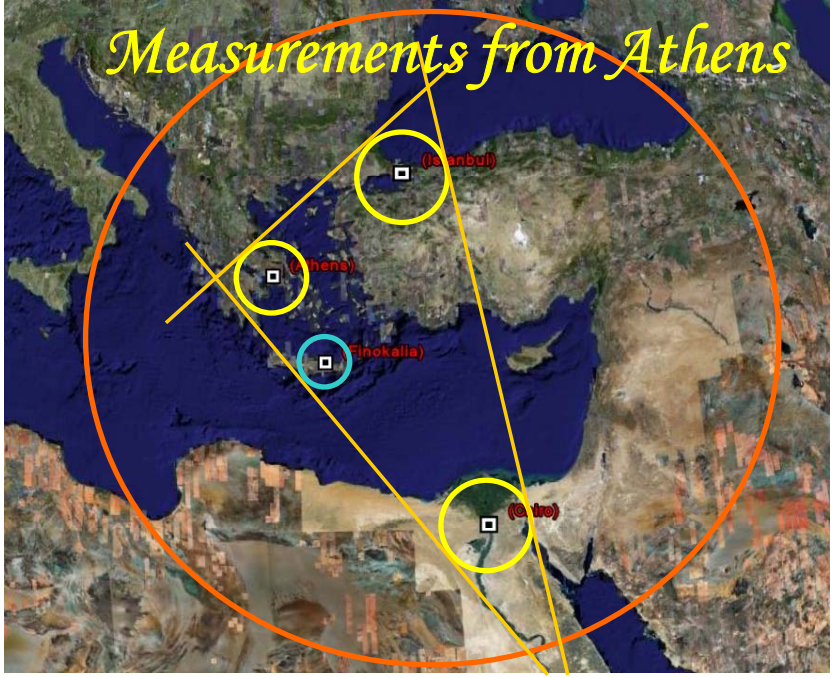
NATIONAL OBSERVATORY OF ATHENS

- **Parameters collected: NO, NO2, O3, SO2, CO, PM10 since 1984 (when available)**
- **Trend analysis, comparison with Istanbul and Cairo Air Quality levels and comparison with satellite data**





From NOA



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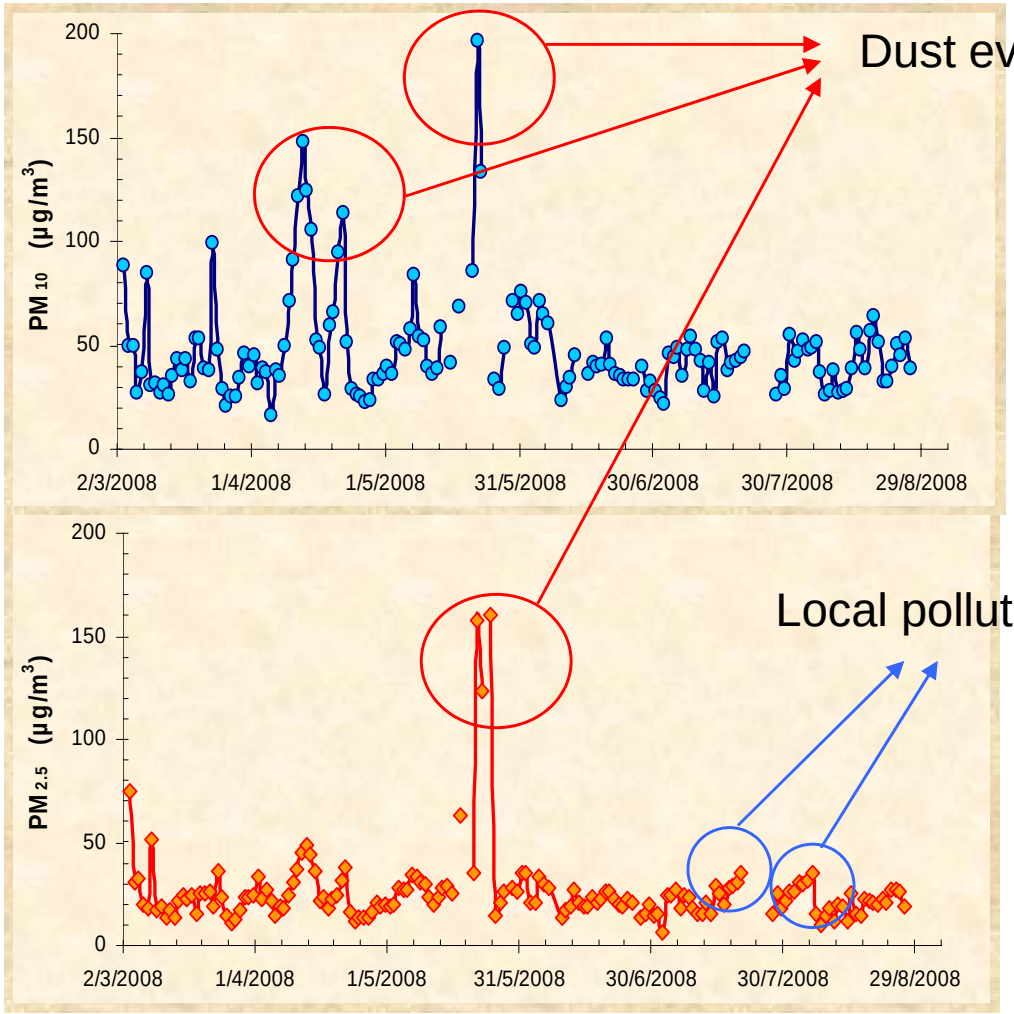
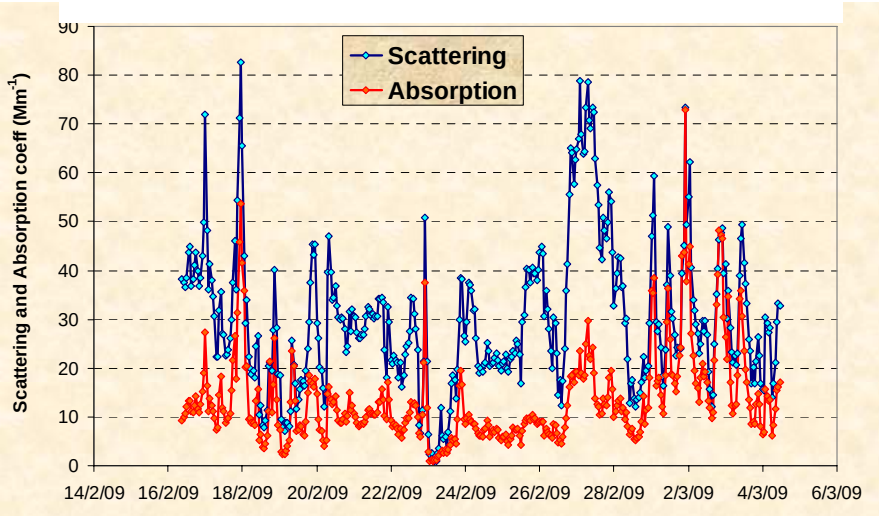


➢ **Continuous monitoring of aerosol optical properties e.g. AOT, scattering and absorption coefficients for the study of the climatic role of aerosols in the area**



➢ **Continuous daily sampling of PM10 and PM2.5 and chemical analyses at Penteli, Athens (urban background) since March 2008 for studying Athens outflow and its contribution on regional background**

(NOA) National Observatory of Athens, Dr. Evangelos Gerasopoulos, egera@meteo.noa.gr

From NOA

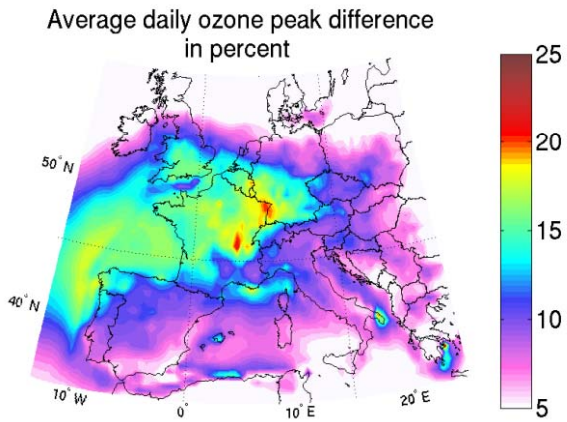
Megacity air quality and climate change

- Qualification of past and present GHG and aerosol emissions from large urban areas
- Case study : summers 2003 and 2007 in Europe
- Reciprocal impacts between air pollution and climate change
- For instance , warmer, wetter and more stagnant future climate will imply (e.g. Jocob and Winner, 2009 and references therein)
  - Higher temperature → ozone increase in polluted areas
  - Higher humidity → decrease in background ozone
  - Higher temperature →more sulfate (more SO_2 oxidation), less nitrate (more evaporation)
  - Changes in precipitation frequency → changes in PM
  - Changes in PBL height and convection (→ mixing), forest fires (sources of CO, PM, …)

→ GCM/CTM studies for 2030-2050 and further analyses of 2003 and 2007 summers in Europe

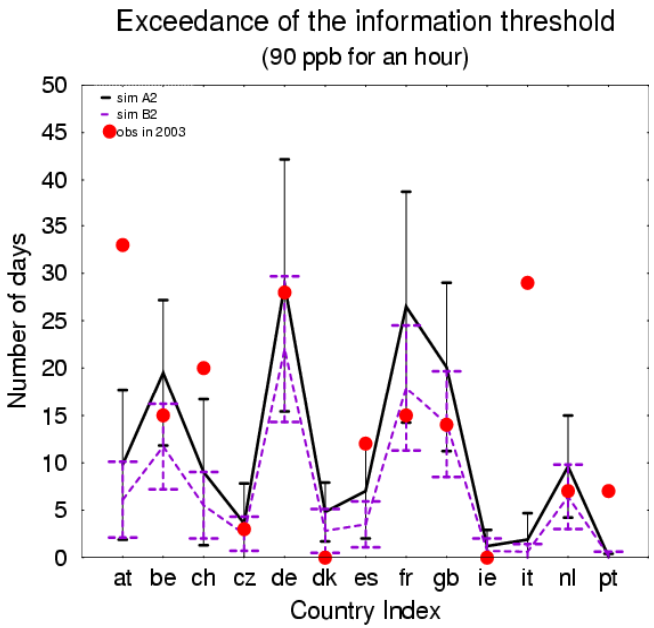
Climate trends for surface ozone

- Difference in average daily peak near surface ozone concentration between A2 and present day.



⇐ Substantial ozone increase over western Europe (France, Germany, Belgium, England …) up to 25% more.

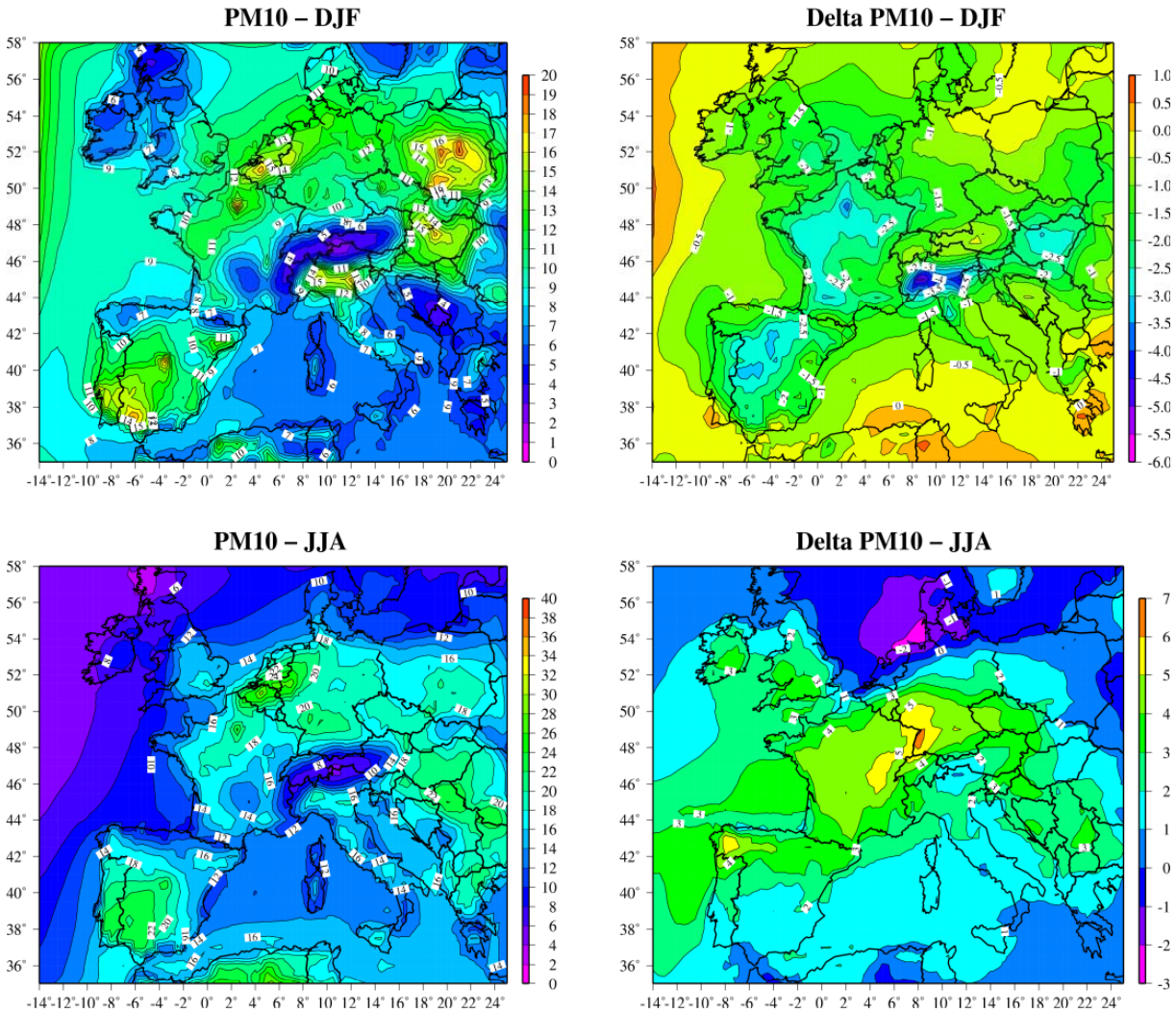
⇒ Ozone episodes such as in 2003 might become more frequent in the future with a longer duration
(Meleux et al., 2007)



From INERIS

Impact on PM concentrations

Present = [1985-1990] **[2070-2075]^{A2} - Present**



Ammonium nitrate:
Evaporation

Over Paris and Milan :
Increasing BLH

Over forest areas :
Increasing SOA formation

Increase of Dust emissions
Over arable lands

From INERIS

Collaboration with MEGAPOLI

- Emissions
  - Country totals, regridding capabilities
- Observations
  - Satellites, local measurements
- Modeling
  - Common experiments with focus on megacities
- Publications
  - IGAC assessment

Conclusions

- **CityZen** integrates different spatial scales both in *observations*, *emission inventories*, and *modeling*
- focus on **air quality** and interactions with **climate** in the past, present and future
- good progress within the participating groups
- interaction between the different scale ‘communities’ still in the planning stage, but about to start
- please visit http://wiki.met.no/cityzen/start or contact michael.gauss@met.no