The CityZen project
Bridging the scales with focus on megacities

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and the CityZen Team

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- *2007 was the first year in history when urban population was larger than rural population (UN)*
- *An increasing part of the world's population may be exposed to poor air quality*

All agglomerations of the world with a population of 1 million inhabitants or more at the reference date **2009-01-01**:

Rank	Name	English Name	Country	Population	Remark
1	Tōkyō	Tokyo	Japan	33,800,000	incl. Yokohama, Kawasaki, Saitama
2	Seoul	Seoul	Korea (South)	23,900,000	incl. Bucheon, Goyang, Incheon, Seongnam, Suweon
3	Ciudad de México	Mexico City	Mexico	22,900,000	incl. Nezahualcóyotl, Ecatepec, Naucalpan
4	Delhi	Delhi	India	22,400,000	incl. Faridabad, Ghaziabad
5	Mumbai	Bombay	India	22,300,000	incl. Bhiwandi, Kalyan, Thane, Ulhasnagar
6	New York	New York	United States of America	21,900,000	incl. Newark, Paterson
7	São Paulo	Sao Paulo	Brazil	21,000,000	incl. Guarulhos
8	Manila	Manila	Philippines	19,200,000	incl. Kalookan, Quezon City
9	Los Angeles	Los Angeles	United States of America	18,000,000	incl. Riverside, Anaheim
10	Shanghai	Shanghai	China	17,900,000	
11	Ōsaka	Osaka	Japan	16,700,000	incl. Kobe, Kyoto
12	Kolkata	Calcutta	India	16,000,000	incl. Haora
13	Karāchi	Karachi	Pakistan	15,700,000	
14	Guangzhou	Canton	China	15,300,000	incl. Foshan
15	Jakarta	Jakarta	Indonesia	15,100,000	incl. Bekasi, Bogor, Depok, Tangerang
16	Al-Qāhirah	Cairo	Egypt	14,800,000	incl. Al-Jizah, Hulwan, Shubra al-Khaymah
17	Buenos Aires	Buenos Aires	Argentina	13,800,000	incl. San Justo, La Plata
18	Moskva	Moscow	Russia	13,500,000	
19	Beijing	Beijing	China	13,200,000	
20	Dhaka	Dacca	Bangladesh	13,100,000	
21	İstanbul	Istanbul	Turkey	12,500,000	
21	Rio de Janeiro	Rio de Janeiro	Brazil	12,500,000	incl. Nova Iguaçu, São Gonçalo
21	Tehrān	Tehran	Iran	12,500,000	incl. Karaj
24	London	London	Great Britain	12,300,000	
25	Lagos	Lagos	Nigeria	11,400,000	
26	Paris	Paris	France	10,000,000	
27	Chicago	Chicago	United States of America	9,850,000	
28	Shenzhen	Shenzhen	China	9,400,000	
29	Wuhan	Wuhan	China	9,000,000	
30	Lima	Lima	Peru	8,850,000	
31	Krung Thep	Bangkok	Thailand	8,750,000	
32	Bogotá	Bogotá	Colombia	8,600,000	
32	Kinshasa	Kinshasa	Congo (Dem. Rep.)	8,600,000	
34	Lahore	Lahore	Pakistan	8,300,000	
34	Nagoya	Nagoya	Japan	8,300,000	

Source:
Thomas Brinkhoff: City Population
http://www.citypopulation.de

Project acronym: CityZen

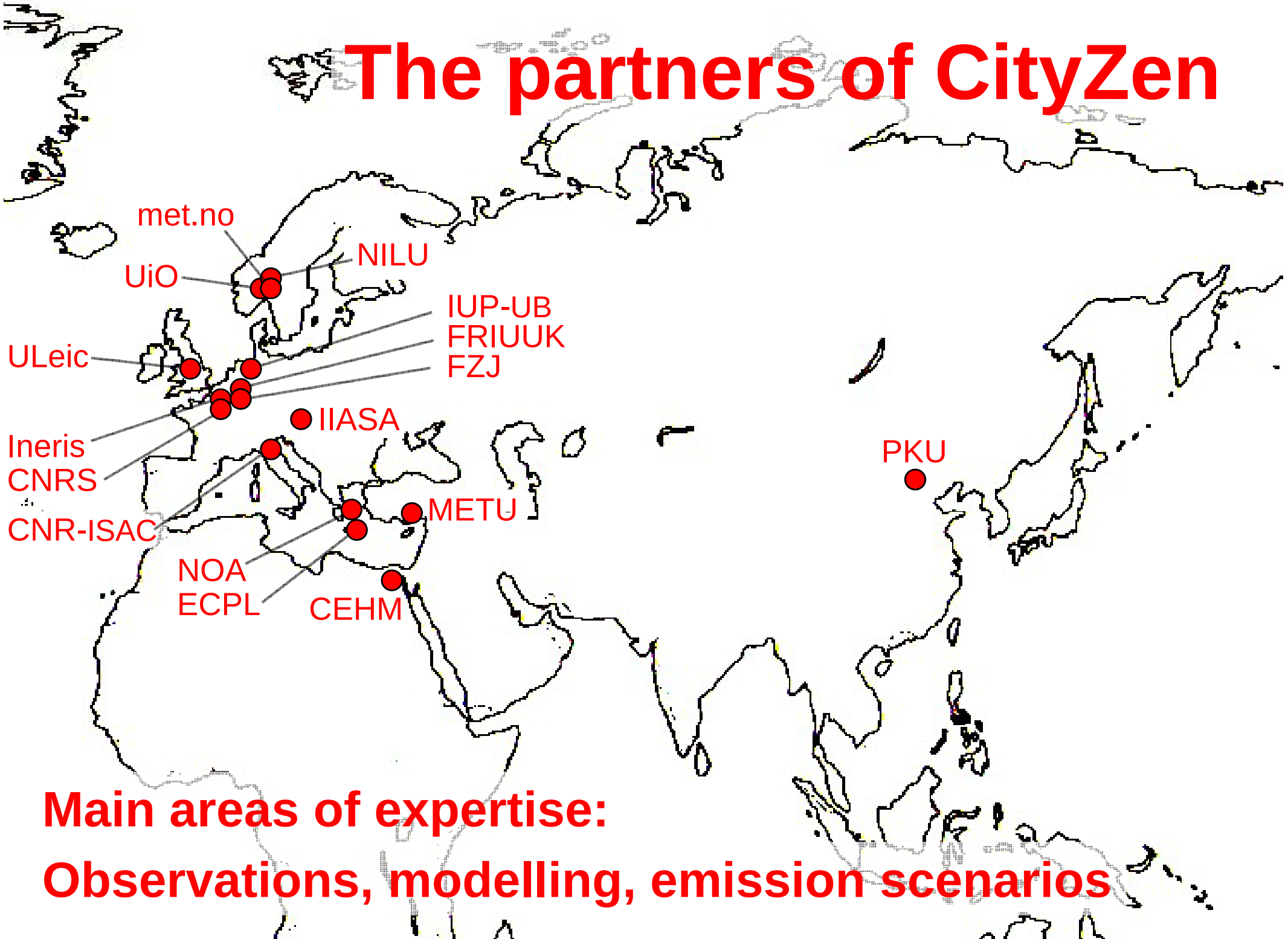
Project full title:
megaCITY - Zoom for the Environment

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**
  - **interaction across the different spatial scales**
- **Estimate how megacities/hot spots influence climate change**
  - **emissions of greenhouse gases, particles, precursors**
  - **different spatial scales**
- **Estimate how megacities are responding to climate forcing**
  - **transport patterns**
  - **chemical oxidation and biogenic emissions**
- **Development of tools to estimate interactions between different spatial scales**
  - **modeling**
  - **analysis of 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**

- Focus on four selected emission hot spots

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

- Interactions between spatial scales

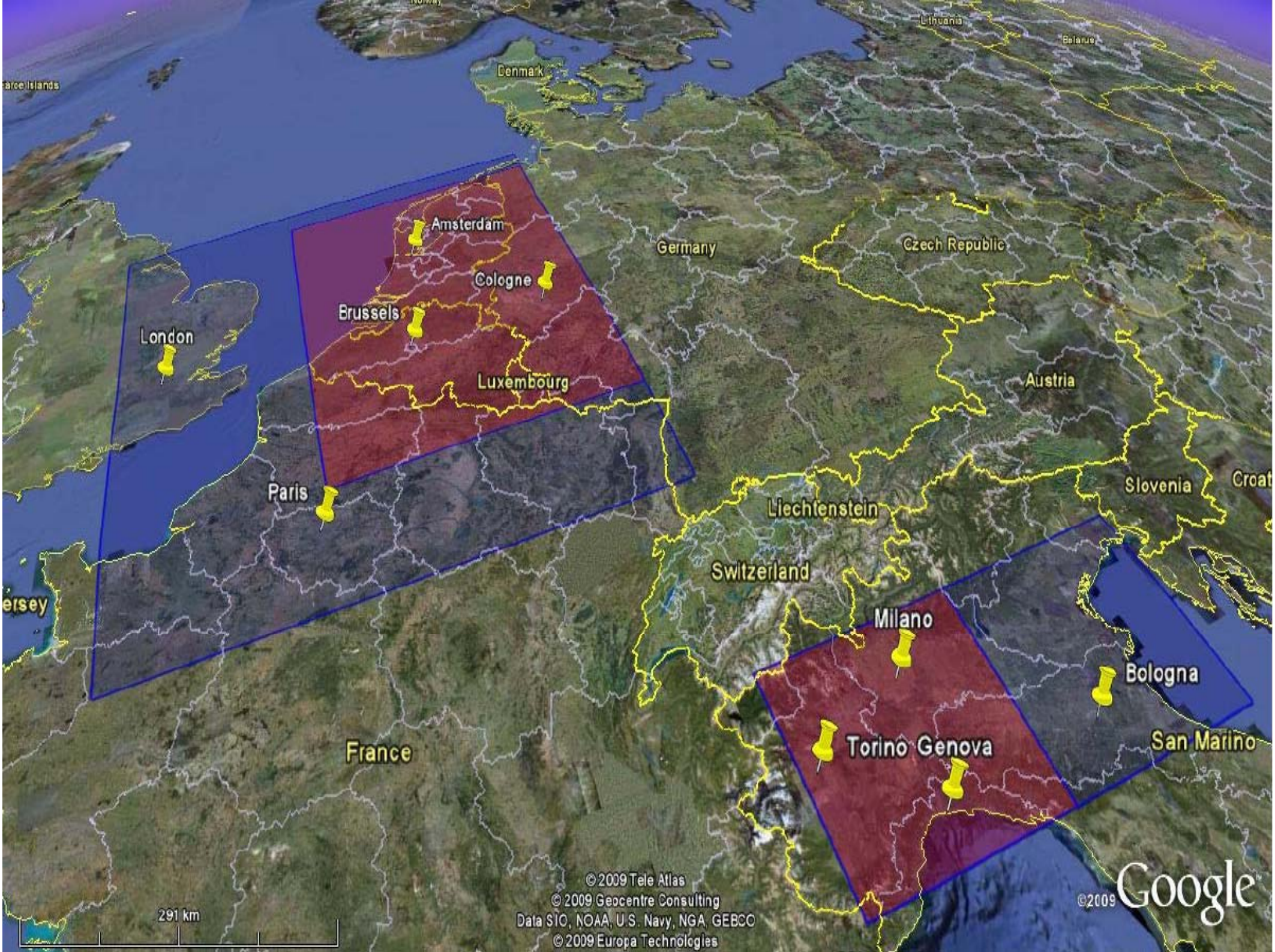
- local
- regional
- global

- Feedbacks

- air pollution → climate
- climate → air pollution

- Case studies

- extreme summer of 2003 (NW and central Europe)
- extreme summer of 2007 (SE Europe)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Cologne
Brussels
London
Luxembourg
Paris
Milano
Torino
Genova
Bologna
San Marino
Germany
Czech Republic
Austria
Slovenia
Liechtenstein
Switzerland
France
Denmark
Lithuania
291 km
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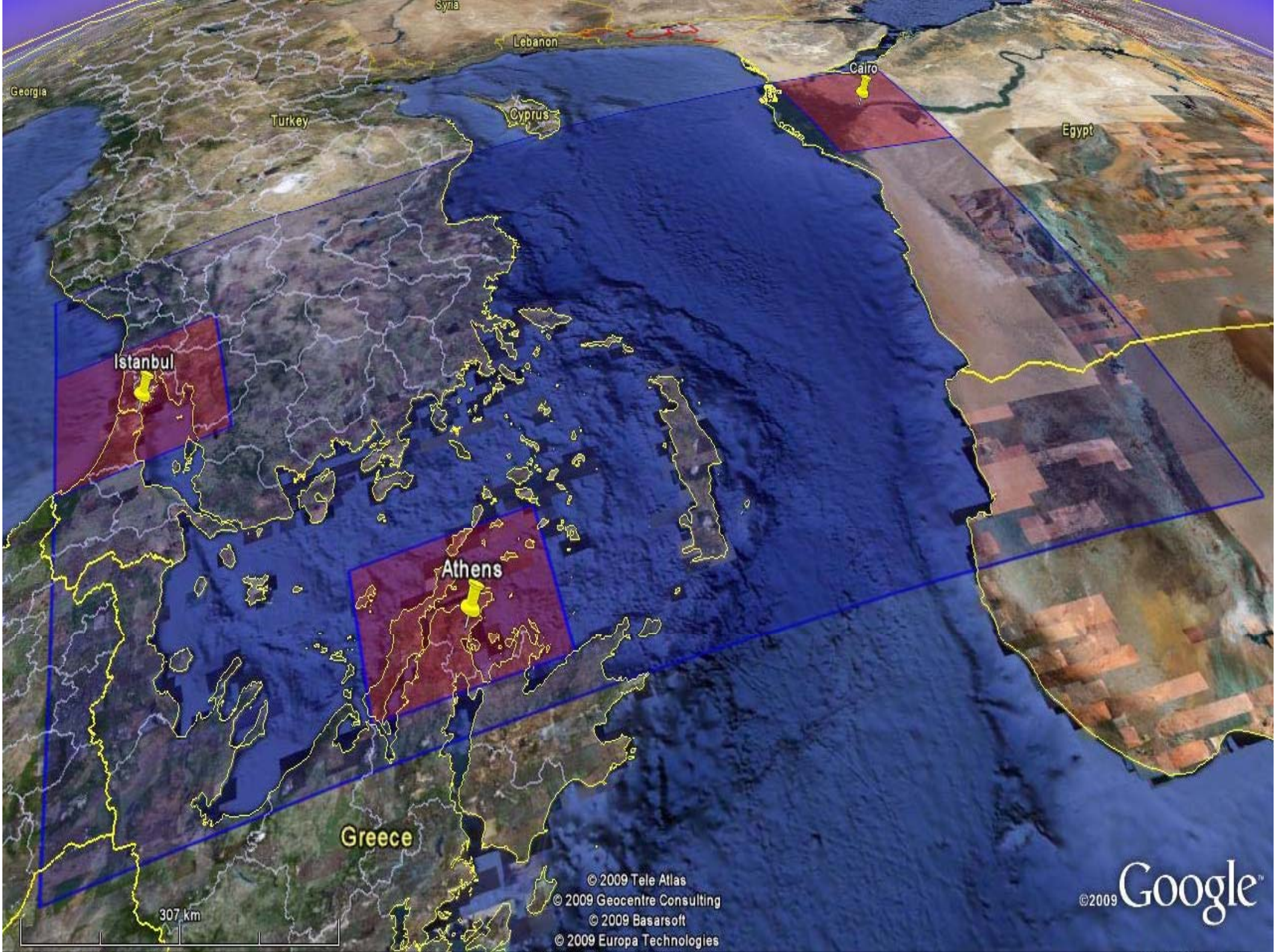
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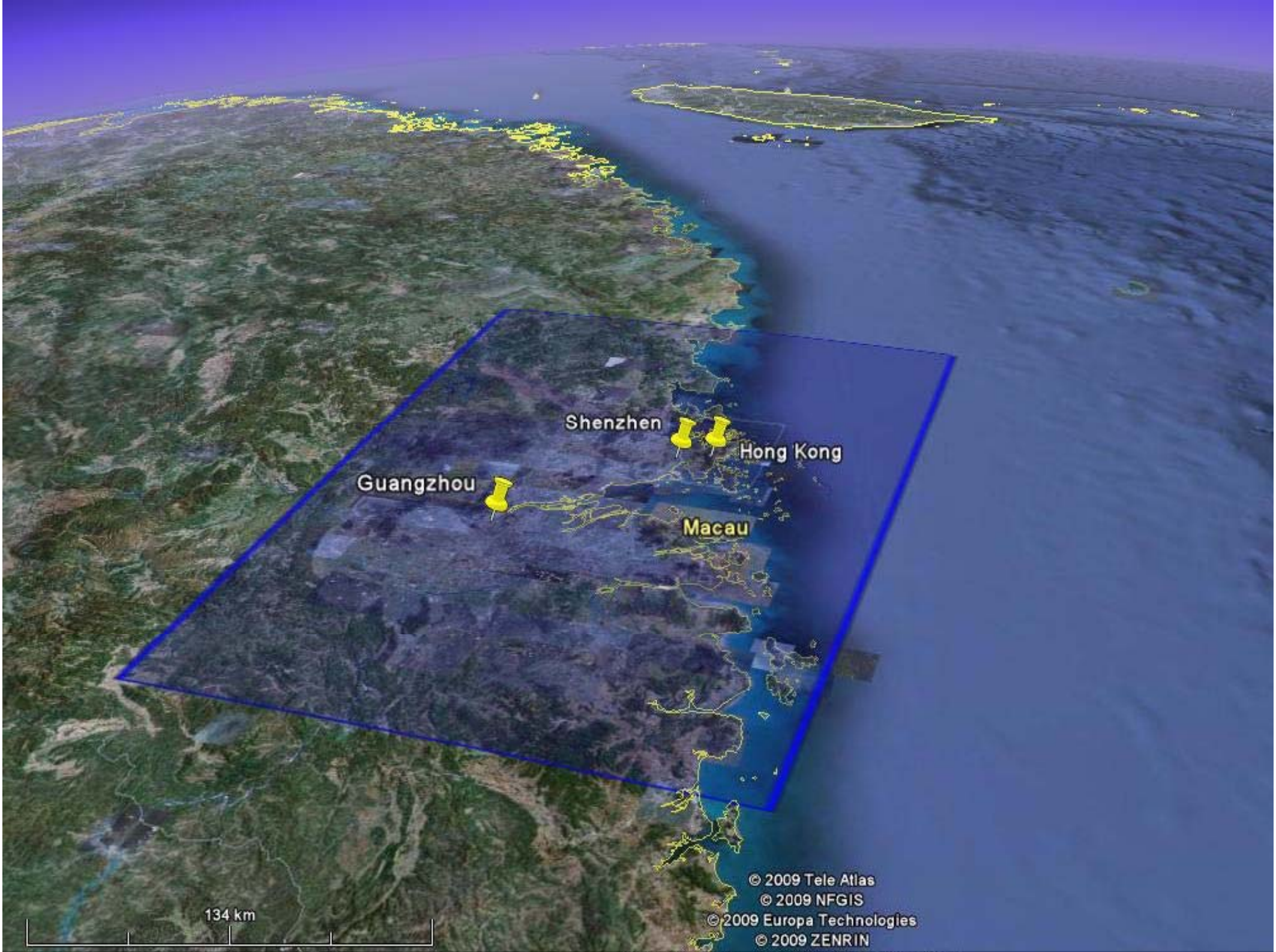
Shenzhen
Hong Kong
Guangzhou
Macau
134 km
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Participating models

- 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)

Measurements in CityZen

- Satellite:
  - Global coverage with GOME, SCIAMACHY, GOME-2, OMI, ...
- Ground-based:
  - Within the four selected hotspot regions of CityZen

Past – present - future

- Trend studies for the last decade using both observations and models
- Process studies to calculate import and export fluxes from megacities
- Future time slices for different emission scenarios (incl. mitigation)

Examples of climate-AQ interactions

Warmer, wetter and more stagnant future climate
(e.g. Jocob and Winner, 2009 and references therein)

- Higher temperature → ozone increase in polluted areas
- Higher humidity → decrease in background ozone in the background
- 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

Model experiments to look at scale interactions

- Boundary conditions derived from global models to be used in finer-scale models
- Improved pollutant export in global models by using output from finer-scale models
- Nesting options (one-way or two-way), to be done by individual models that have this capability
- Tracer transport experiments to be done by all model groups

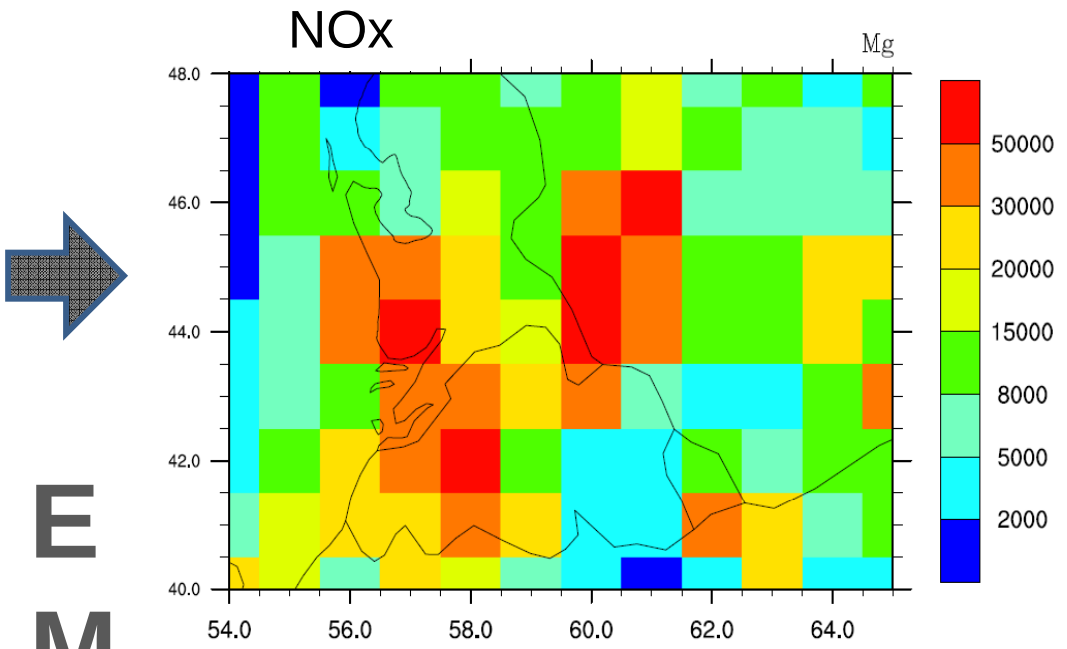
IUP - University of Bremen

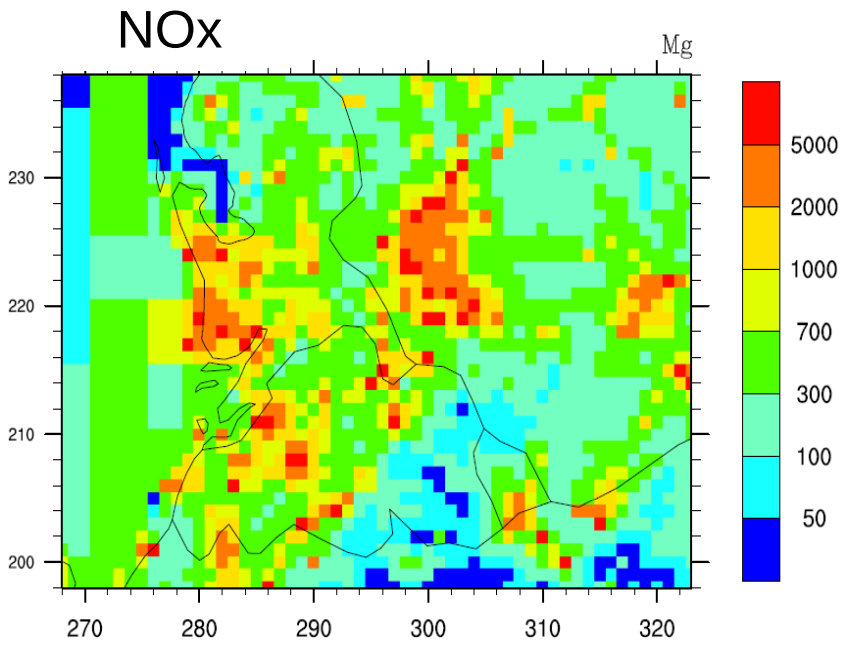
- Data set of tropospheric columns of NO2, SO2, HCHO, and OCHCHO over selected areas from GOME, SCIAMACHY and GOME-2 (1995 – 2009)
- Data set of aerosol optical depth over selected areas from SeaWiFS and MERIS data

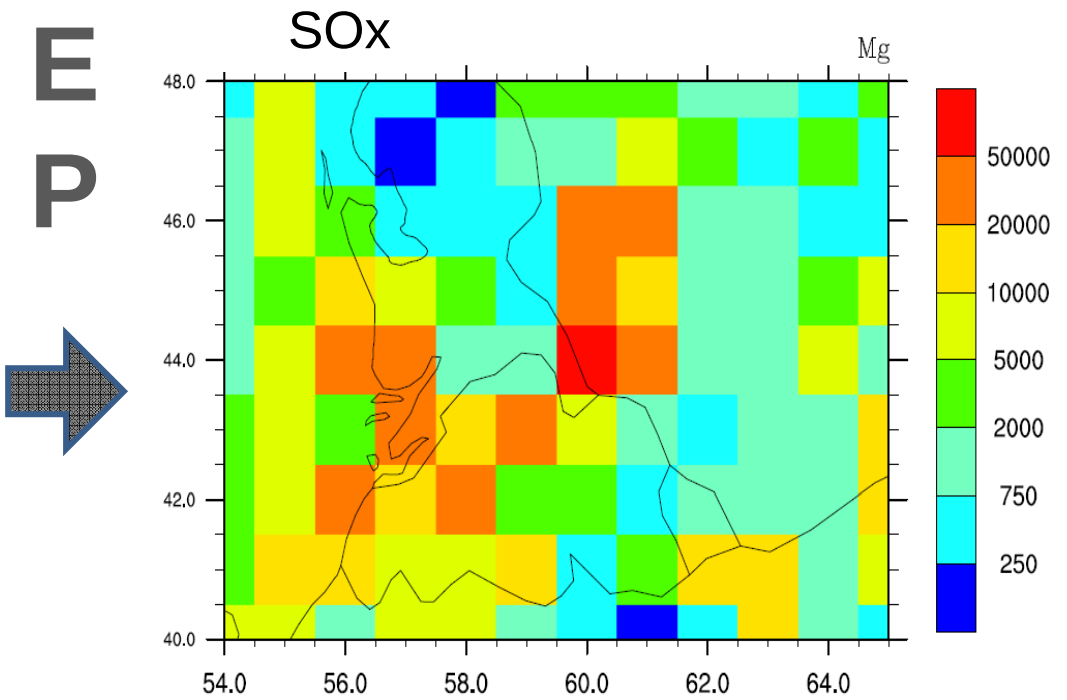
IUP - partner #5

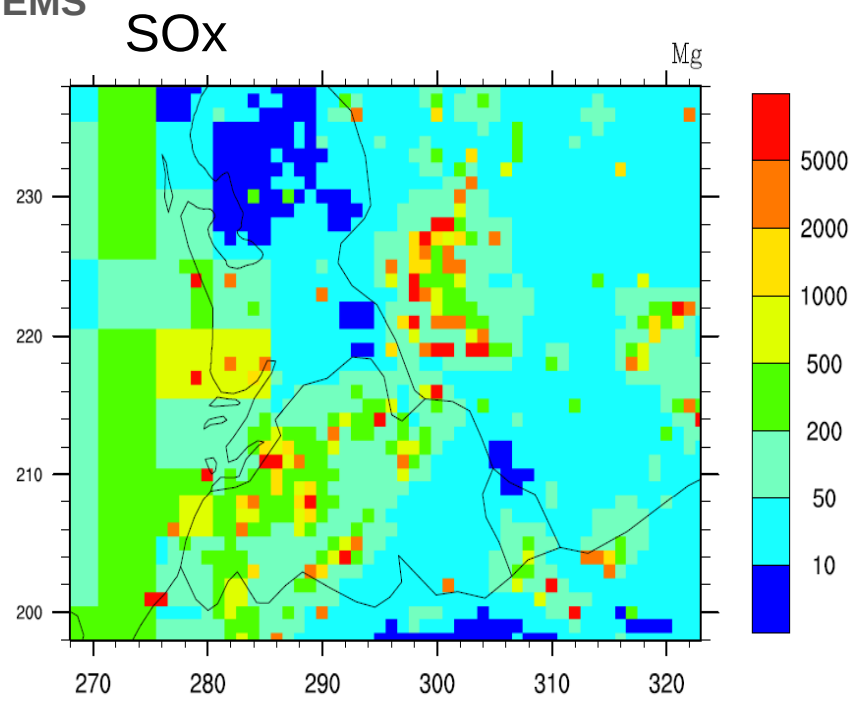
EMEP

TNO GEMS

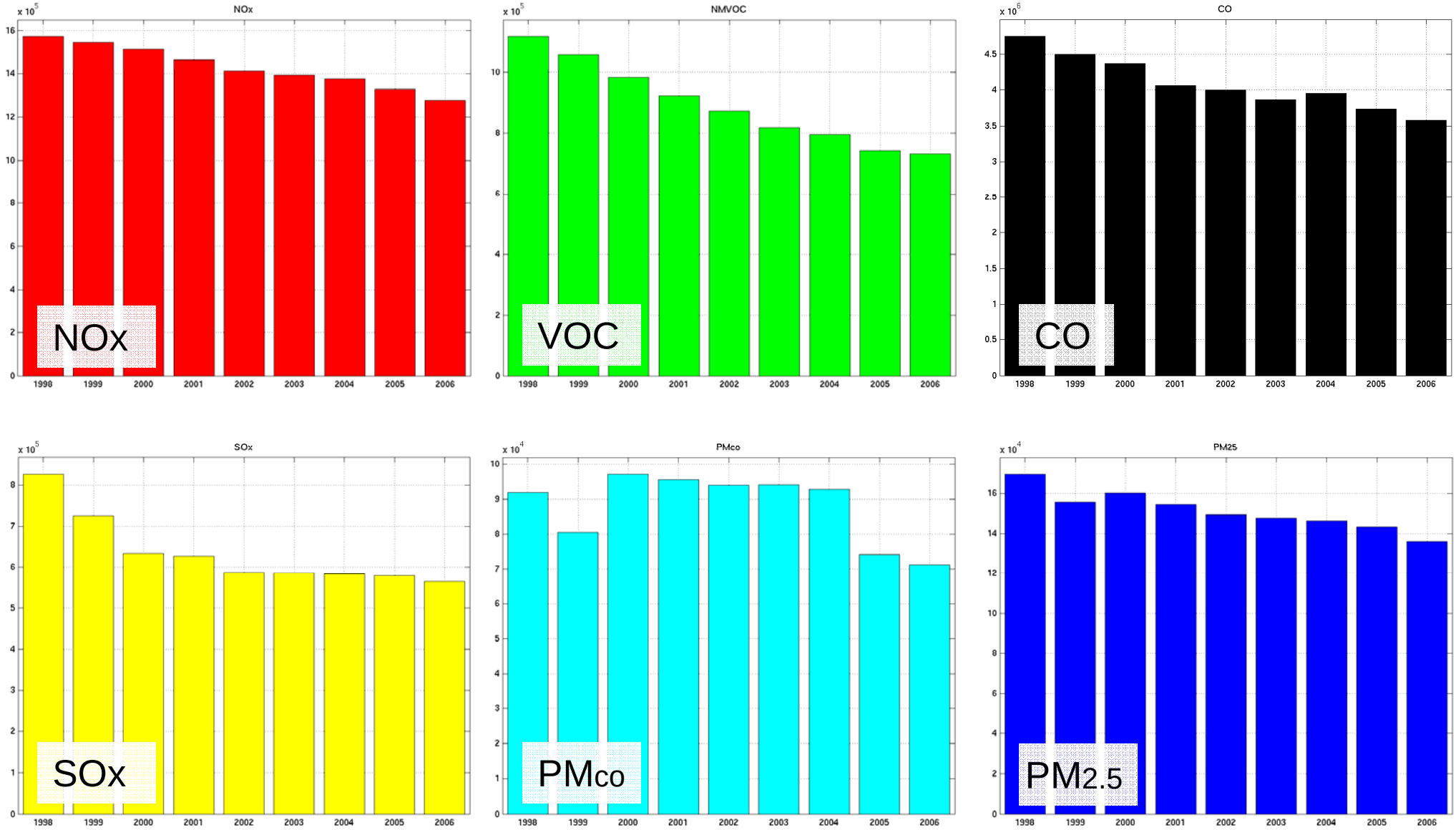








metno - partner #1

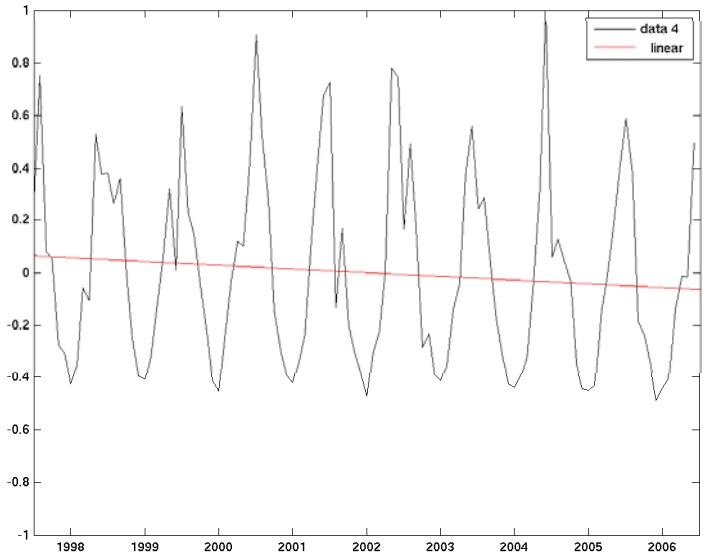


Example: BeNeLux+Ruhr emissions 1998-2006 (EMEP) [kt/yr]

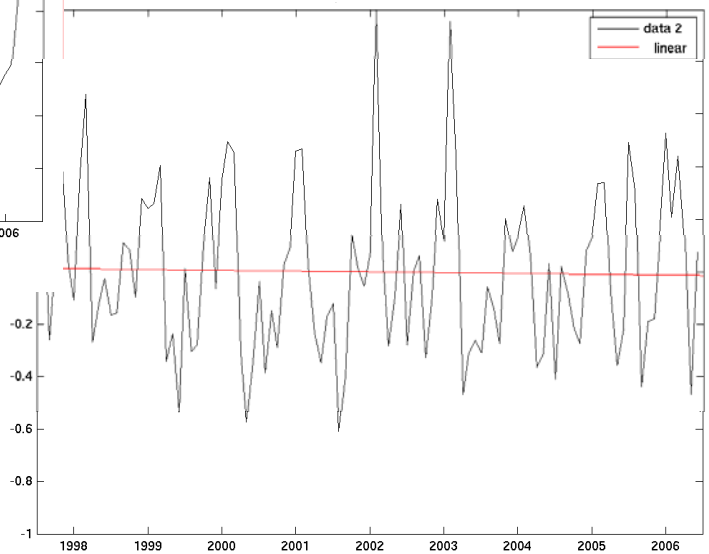
metno - partner #1

Just a warm-up…

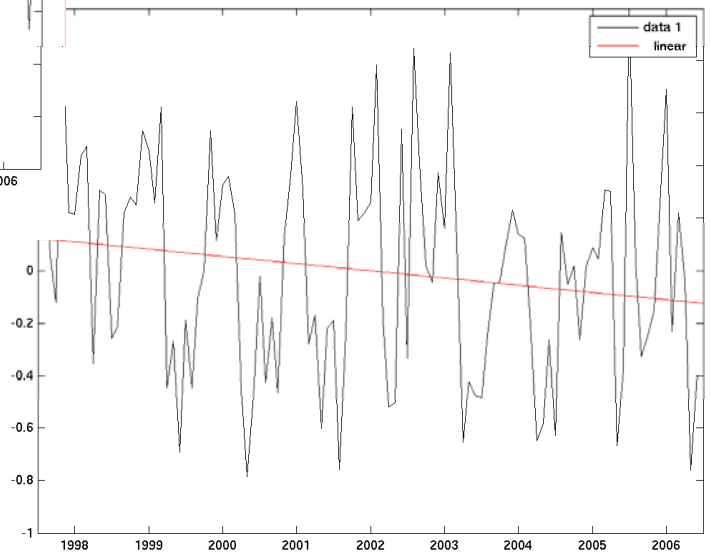
NOx (norm.)



particulate nitrate (norm.)



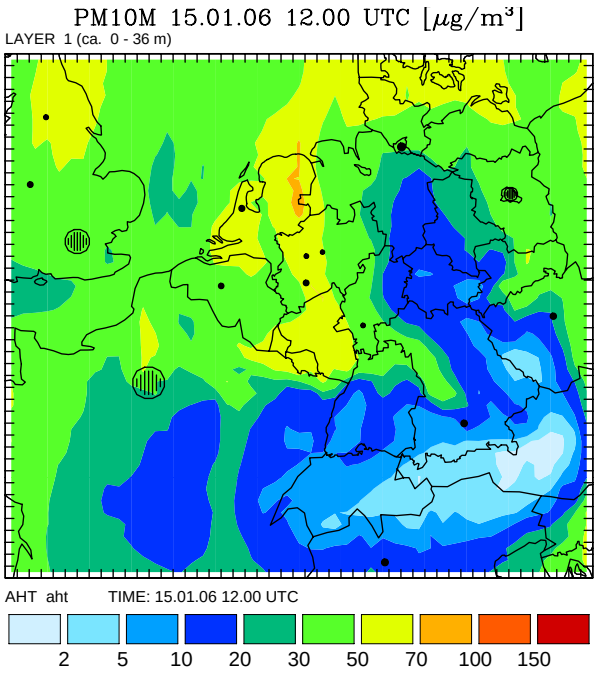
SO_4 (norm.)



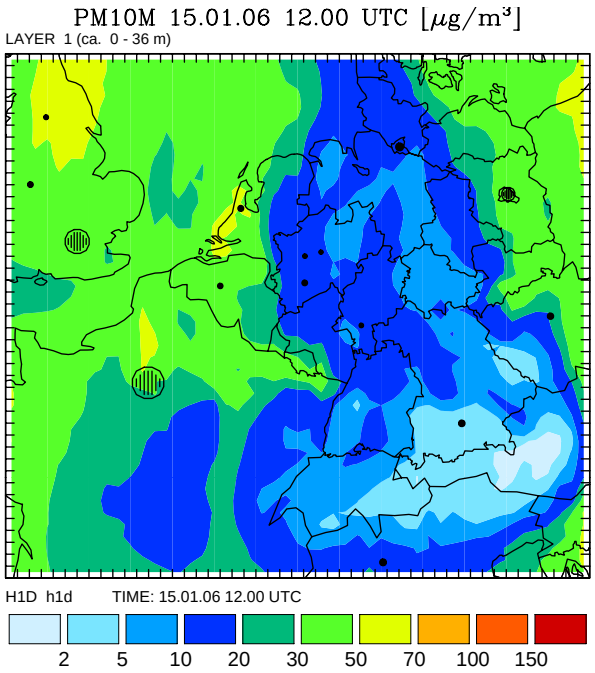
Example: BeNeLux+Ruhr surface concentrations 1998-2006 (EMEP UM)

SPECIFIC EPISODES: PM10, Jan 15, 2006

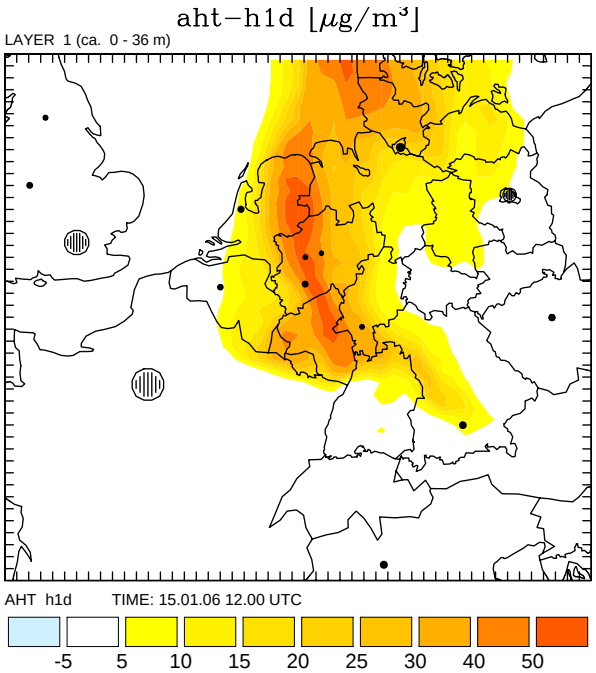
Base Case



Scenario: no Emi-GER



Base - noEmi-GER

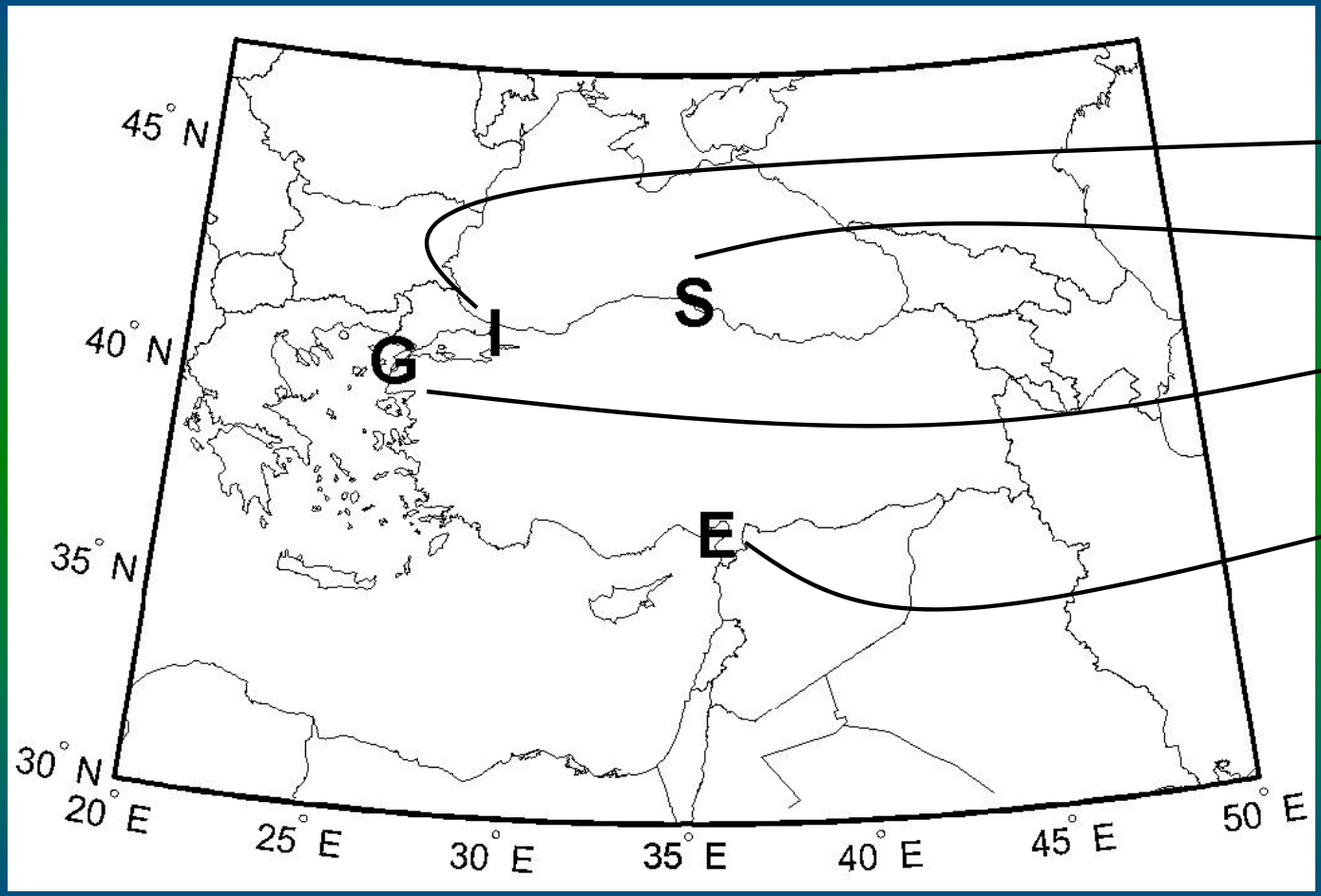


Transport dominated episode over North-Rhine-Westphalia, PM10 concentrations in NRW mainly due to inflow from south

FRIUUK - partner #6

Institute of Marine Sciences (IMS)
Middle East Technical University (METU)

Sampling Sites



İstanbul (Mega City)

Sinop (Small City)

Gökçeada (Island) (Imbros)

Erdemli (Rural)

Collaborator Universities:

I : Istanbul Technical University

G: Istanbul University

S: Sinop University

METU - partner #12

Sampling

Samplers are ready for aerosol collection at 4 sites (Erdemli, Istanbul, Imbroz, Sinop)

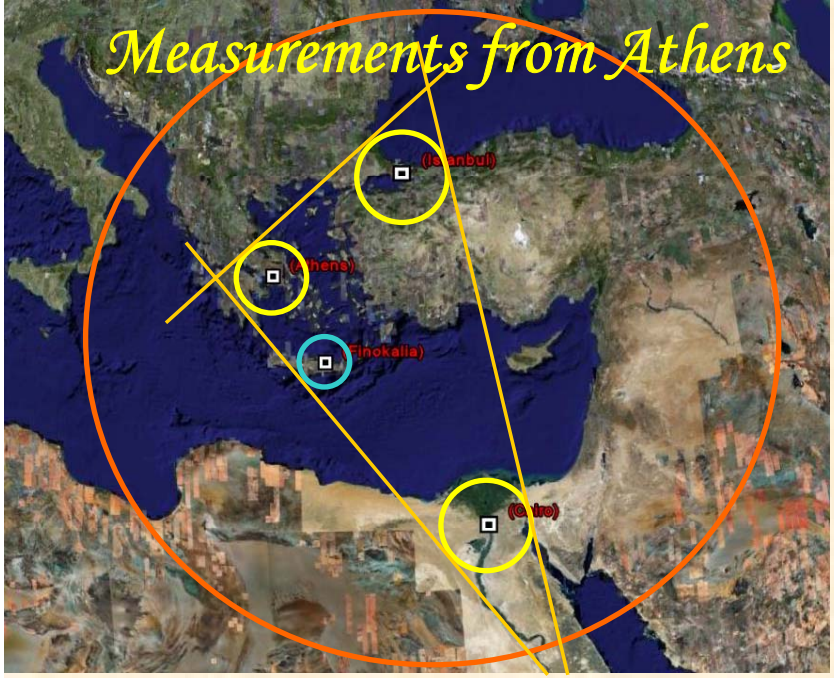
Gent type SFU

Analysis (at ECPL)

Ion Chromatography : Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}, Cl^-, Br^-, NO_3^-, $C_2O_4^{2-}$, SO_4^{2-}, MS^-

Inductively Coupled Plasma Mass Spectrometry (ICP-MS) : Al, Fe, Mn, Ca, Cr, Cu, Zn, Pb, Cd

Thermo-optical Carbon analysis: OC/EC



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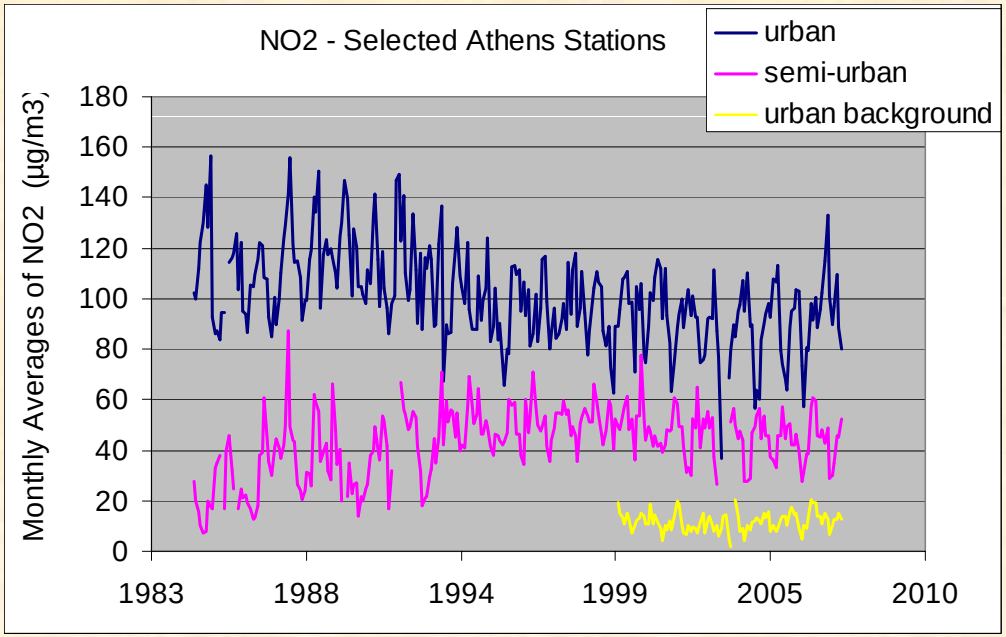
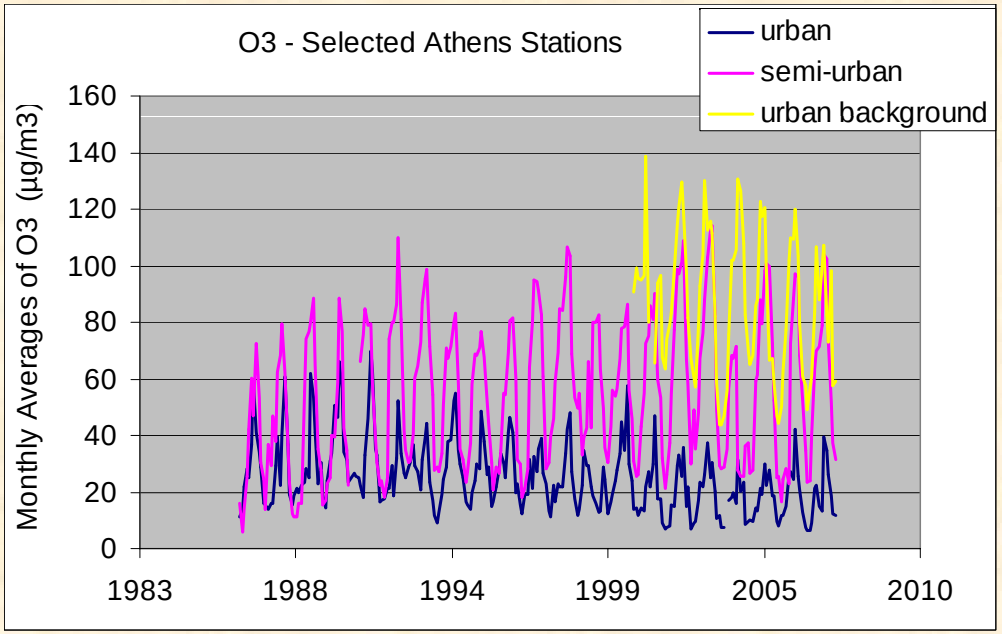
NATIONAL OBSERVATORY OF ATHENS

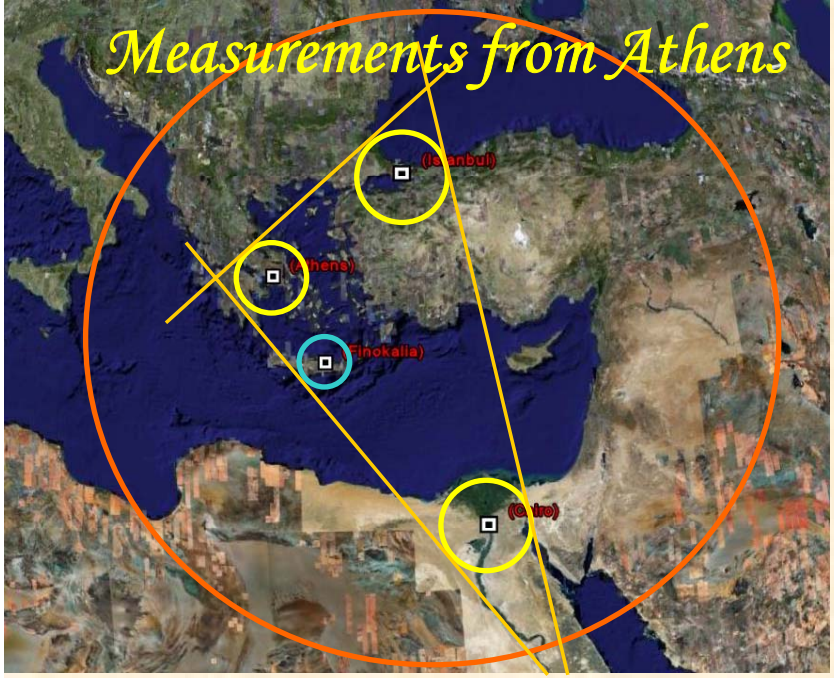
- **Parameters collected: NO, NO2, O3, SO2, CO, PM10 since 1984 (when available)**
- **Trend analysis, comparison with Istanbul and Cairo Air Quality levels and comparison with satellite data**





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

NOA - partner #15



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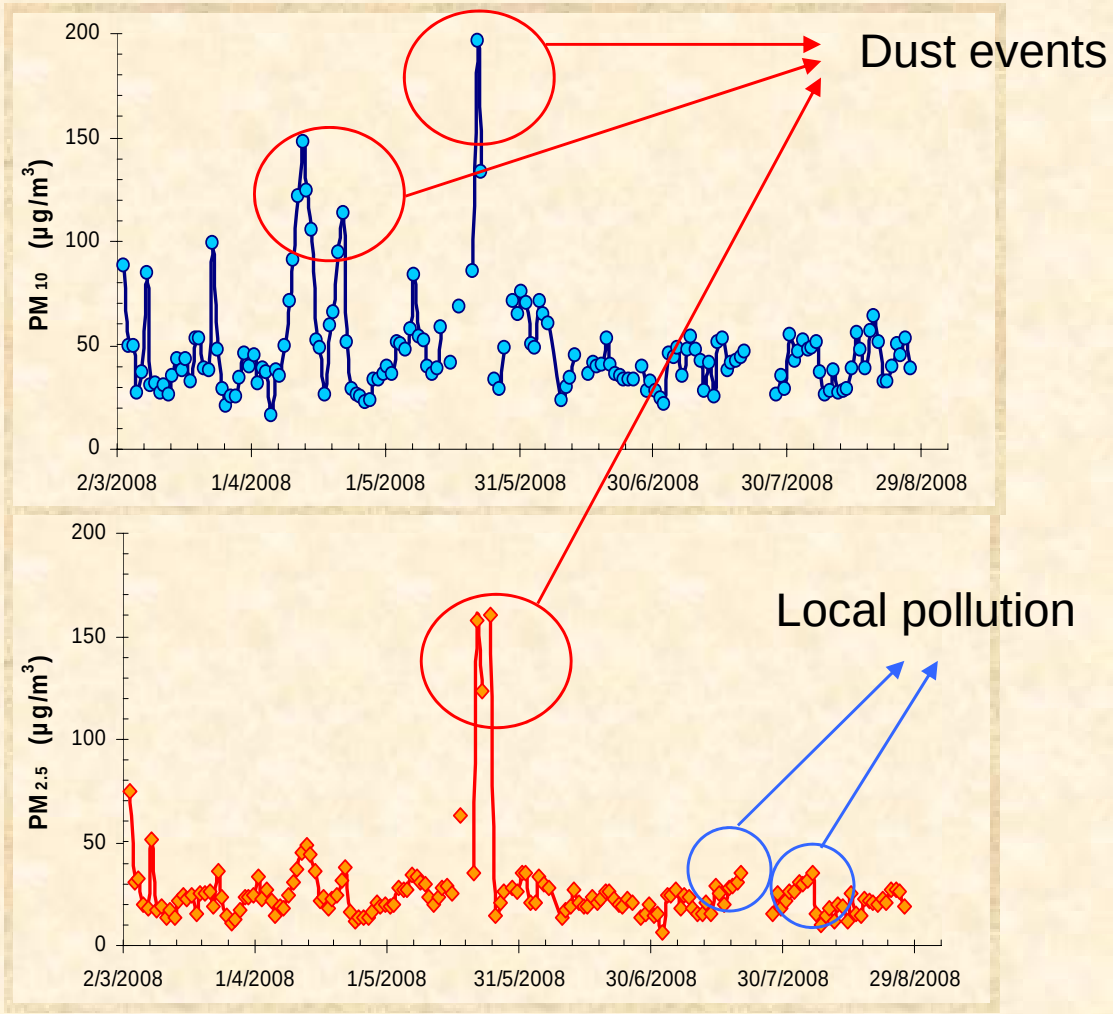
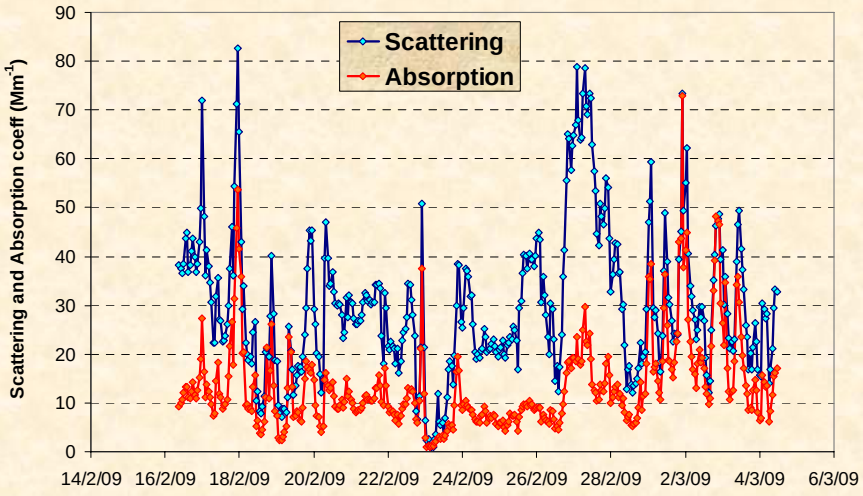


➢ **Continuous monitoring of aerosol optical properties e.g. AOT, scattering and absorption coefficients for the study of the climatic role of aerosols in the area**



➢ **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

NOA - partner #15

Collaboration with MEGAPOLI

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

CityZen on this conference:

- *Vrekoussis, M., et al.:* **SPATIAL AND TEMPORAL VARIABILITY OF NO2 MIXING RATIOS INFERRED FROM SATELLITE AND GROUND-BASED OBSERVATIONS ABOVE SE EUROPE: ROLE OF MEGACITIES**
- *Memmesheimer, M., et al.:* **AIR POLLUTION IN THE BENELUX/RHINE-RUHR AREA: SCENARIOS AND INTERANNUAL VARIATIONS BASED ON MODEL CALCULATIONS** (presented by H. Jakobs)
- *Hodnebrog, Ø., et al.:* **URBAN AND REGIONAL SCALE INTERACTIONS IN OZONE FORMATION** (presented by *F. Stordal)*
- *Gauss, M., et al.:* **THE CITYZEN PROJECT – BRIDGING THE SCALES WITH FOCUS ON MEGACITIES**
- *Richter A.:* **USING SATELLITE MEASUREMENTS TO STUDY THE IMPACT OF MEGACITIES ON AIR POLLUTION**

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