

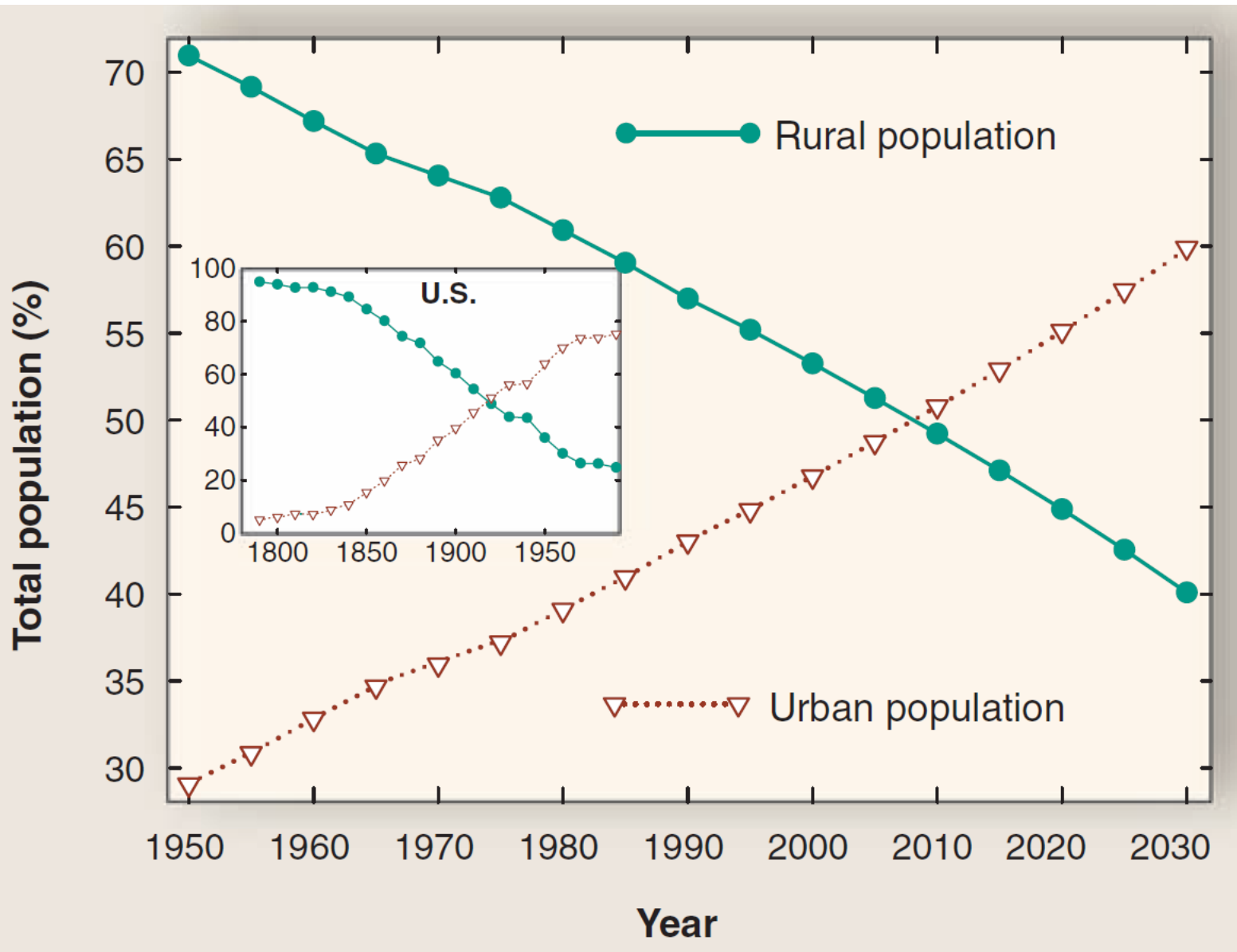
The CityZen project

Bridging the scales with focus on megacities



**Michael Gauss (met.no)
and the CityZen team**

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Change in world urban and rural population (%) from 1950 to 2030 (projected). Inset shows comparable data for the United States from 1790 to 1990. From Grimm et al., 2008.

Grimm, N. B., S. H. Faeth, N. E. Golubiewski, C. L. Redman, J. Wu, X. Bai, J. M. Briggs, 2008: Global Change and the Ecology of Cities. *Science*, 319, DOI: 10.1126/science.1150195.

Outline

- The CityZen project
 - Partners, objectives, tools, ongoing activities
- Various examples of nesting in CityZen
 - EURAD, CHIMERE, EMEP, WRF-CHEM
- A few thoughts, and: *the way forward*

Project acronym: CityZen

Project full title:
megaCITY - Zoom for the Environment

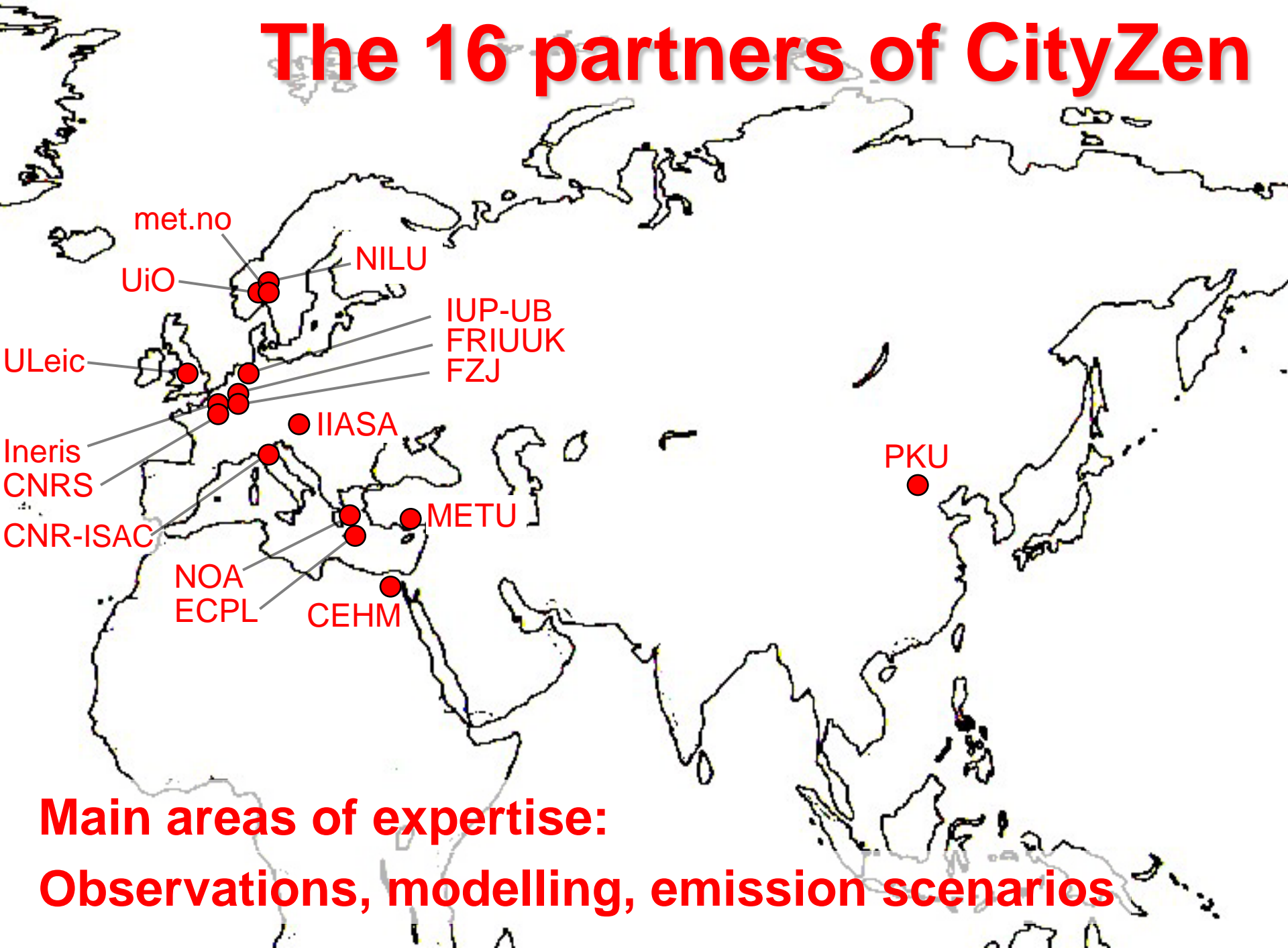


Total budget: ~ 4 m€

Duration: 3 years (start: September 2008)

Sister project: MEGAPOLI

The 16 partners of CityZen



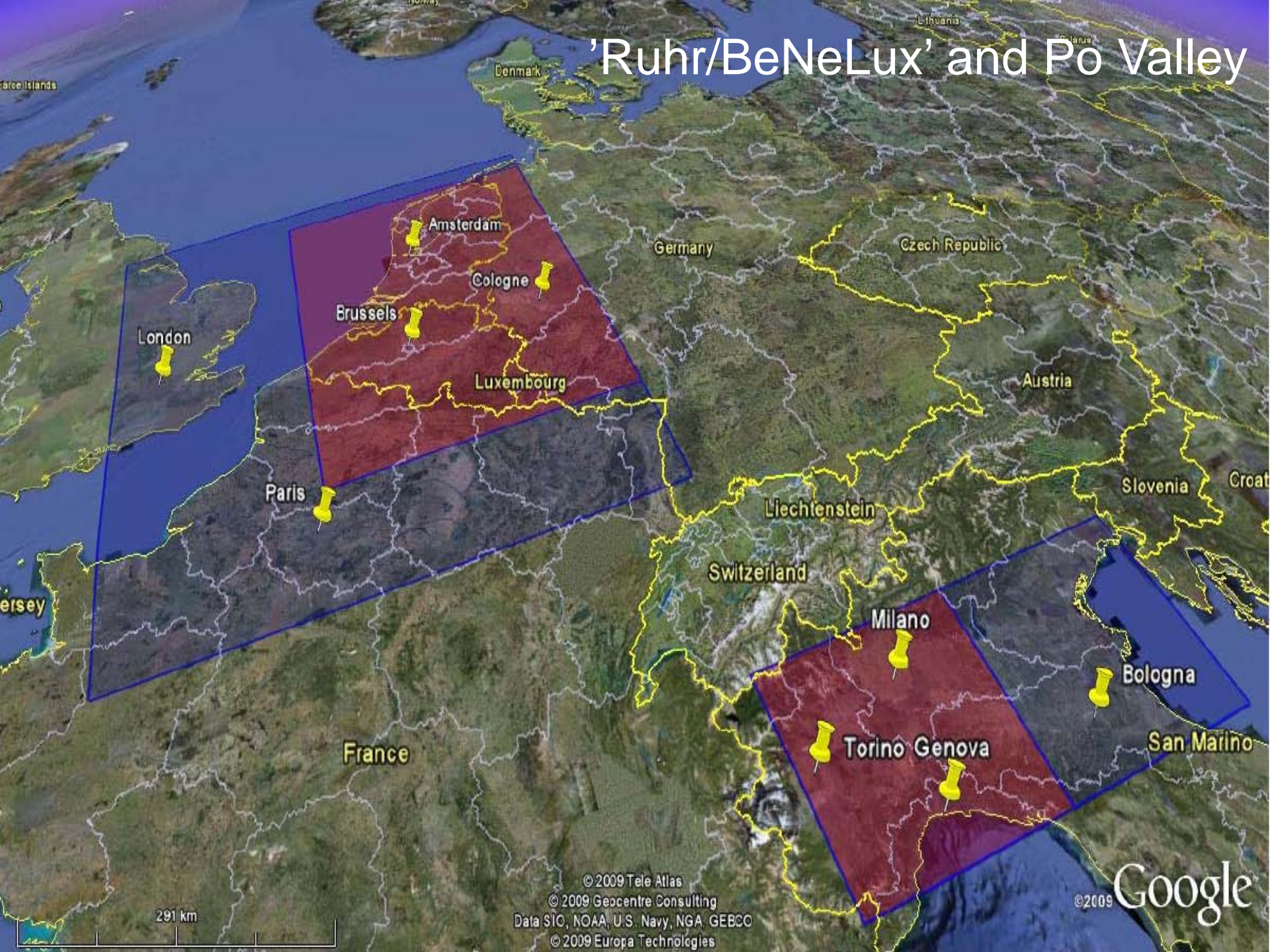
Main areas of expertise:

Observations, modelling, emission scenarios

The main objectives of CityZen

- **Quantify and understand current air pollution in and around selected megacities**
- **Development of tools to estimate interactions between different spatial scales**
- **Estimate how megacities influence air quality and climate, locally and globally**
- **Estimate how megacities are responding to climate change**
- **Estimate the impact of future emission change, including mitigation options**
- **Provide technical underpinning of policy work**

'Ruhr/BeNeLux' and Po Valley





Eastern Mediterranean

© 2009 Geocentre Consulting
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Pearl River Delta + Hong Kong



Guangzhou

Shenzhen

Hong Kong

Macau

134 km

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Measurements in CityZen

- Satellite
 - GOME, SCIAMACHY, GOME-2, OMI, ... : IUP-UB
 - IASI, ACE, CALIPSO : CNRS
- Ground-based
 - CityZen partners in the four selected hotspot regions to provide continuous measurement data and field campaign results

Emission inventories in CityZen

- 1998-2007 in **Europe** : EMEP data (50km*50km) spatially regridded using TNO data (10km*10km), GLOBCOVER (300m) : INERIS, met.no, TNO
- Fine scale data sets for selected hotspots to be merged into European data set: LANUV, AUTH, ARIANET, ITU
- 1998-2007 **global** : a consolidated dataset built upon the databases used for developing scenarios for IPCC-AR5: CNRS
- **Future** projections for Europe and Asia, RCP, incl. mitigation: IIASA
- Possible cooperation with MACC and MEGAPOLI

Models participating in CityZen

- Global scale:
 - MOZART, ECHAM5-HAMMOZ, EMEP, OsloCTM2, CAM-Oslo, TM4-ECPL (~1°x1° resolution)
- Regional scale :
 - CHIMERE, EMEP, EURAD, BOLCHEM, Models-3/CMAQ, WRF-Chem (~0.5°x0.5° resolution)
- Local scale :
 - CHIMERE, EMEP, EURAD, BOLCHEM, Models-3/CMAQ, WRF-Chem (~10x10 km² resolution and finer)

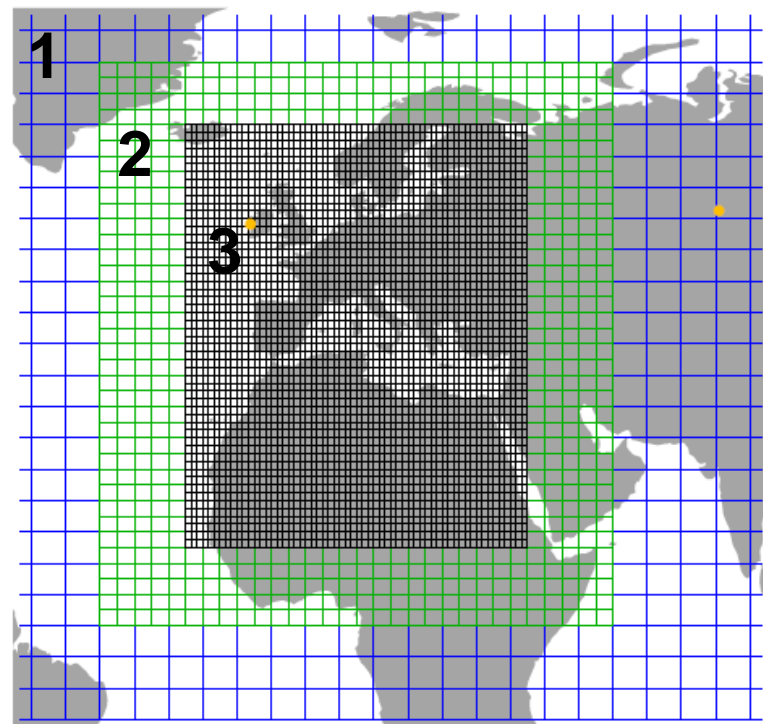
Current activities

- Continuous measurements in selected hot spots
- Provision of emission data sets
- Model experiments looking at trends
- Zooming and nesting approaches in models



Two-way nesting in TM5 According to Krol et al. 2005

Atmos. Chem. Phys., 5, 417–432, 2005
www.atmos-chem-phys.org/acp/5/417/



Operator splitting and transfer of information:

t t + $\Delta T/2$

region 1	↓X↓YZ	VC
region 2↓X↓YZ.....VC CVZ↓Y↓X.....↑.....	
region 3XYZVC CVZYX↑.....CVZYX XYZVC↑.....	

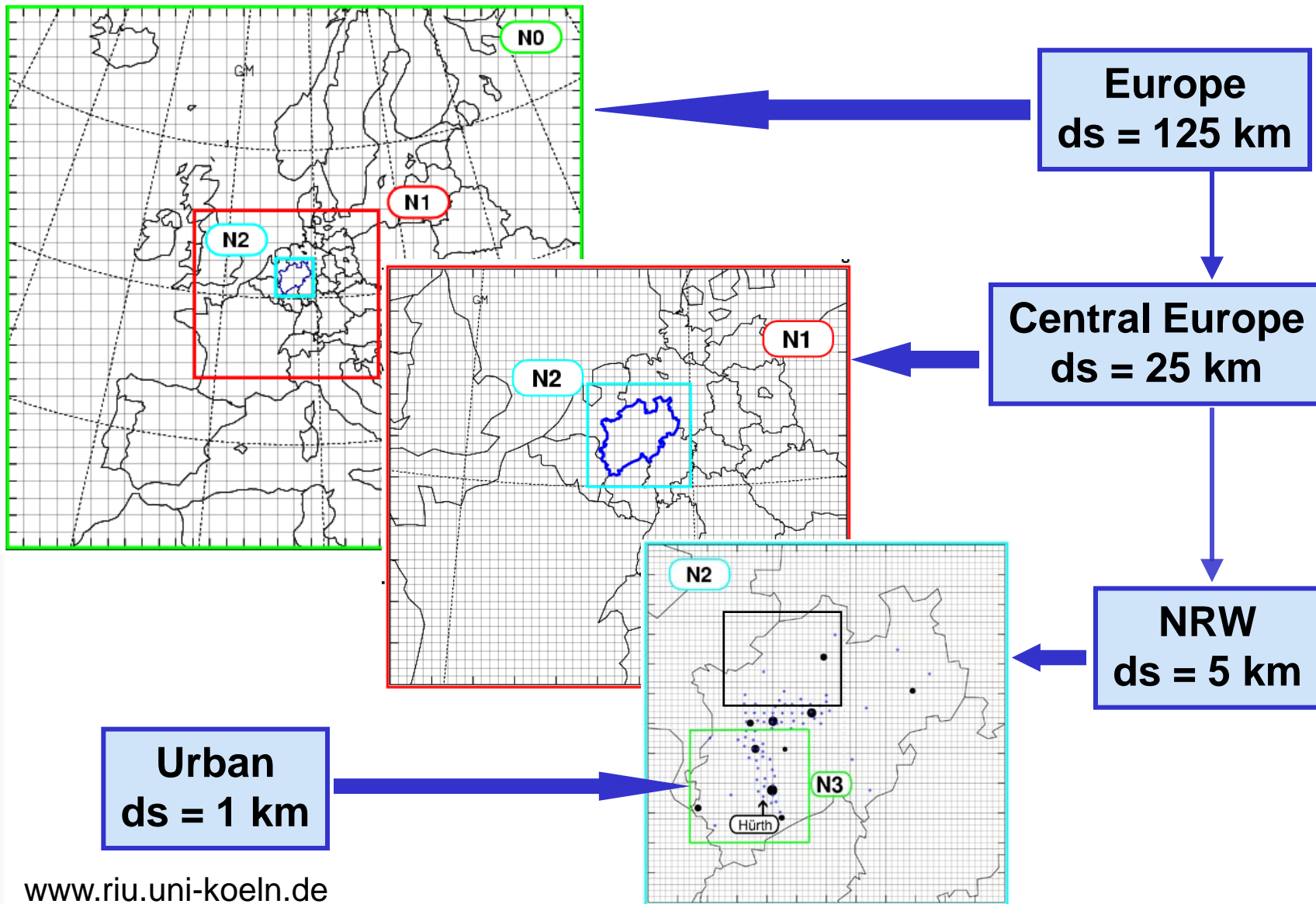
t + $\Delta T/2$ t + ΔT

region 1	CVZ↓Y↓X.....	
region 2CVZ↓Y↓X.....↓X↓YZ.....VC↑	
region 3CVZYX XYZVC↑.....XYZVC CVZYX↑.....	



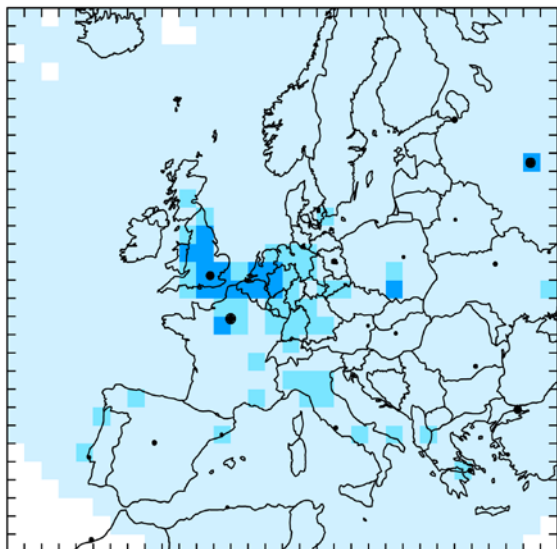
EURAD nesting

TOOLS AND METHODS: EURAD-SYSTEM



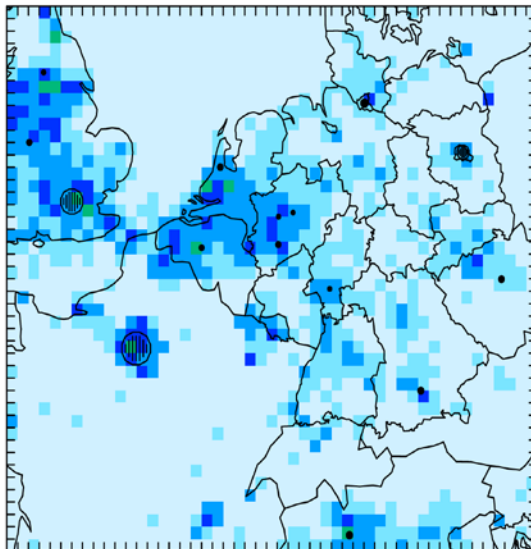
MODEL INPUT, EMISSIONS, NO

NO (2002) [g/(s km²)]



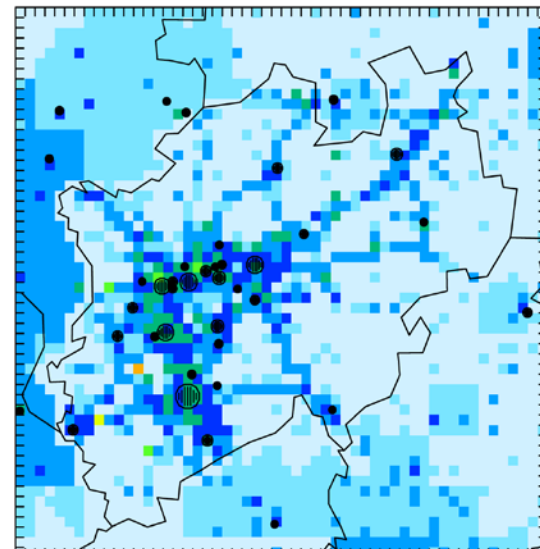
ATL EMEP TIME: 01.10.02 6.00 UTC
0.1 0.2 0.5 1 5 10 20 50 150

NO (2002) [g/(s km²)]



ATL EMEP TIME: 01.10.02 6.00 UTC
0.1 0.2 0.5 1 5 10 20 50 150

NO (2002) [g/(s km²)]



ATL LUA TIME: 01.10.02 6.00 UTC
0.1 0.2 0.5 1 5 10 20 50 150

Europe, 125 km

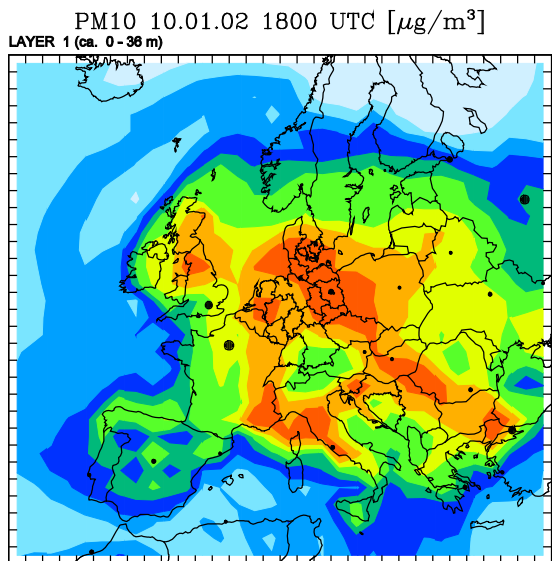
EMEP/TNO

Central Europe, 25 km

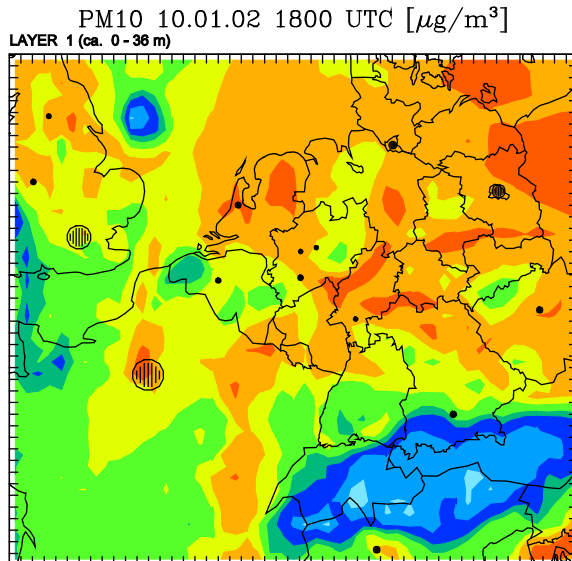
EMEP/TNO

NRW, 5 km

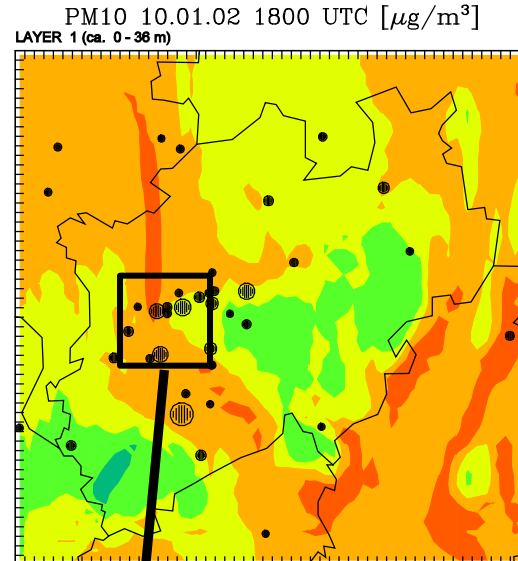
LANUV-NRW



AZUR 2002 TIME: 10.01.02 18.00 UTC

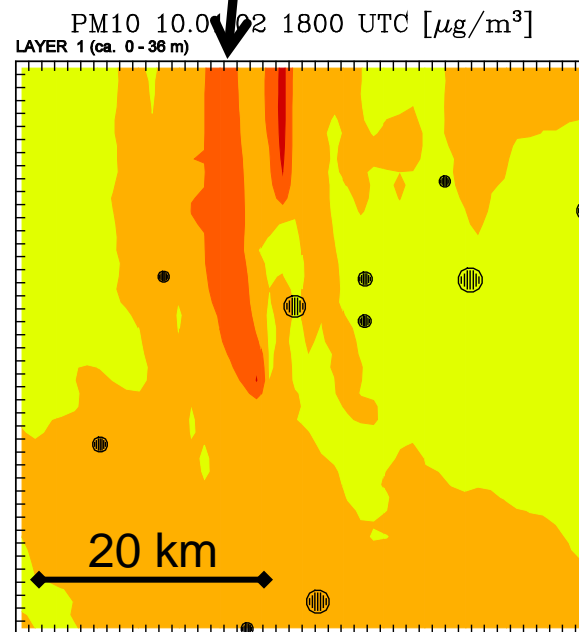
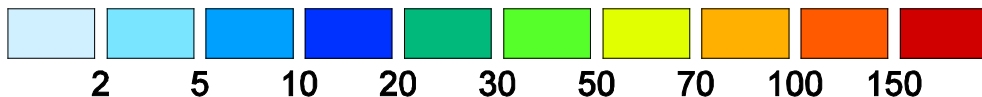


AZUR 2002 TIME: 10.01.02 18.00 UTC



AZUR 2002 TIME: 10.01.02 18.00 UTC

PM10, 10 Oct 2002, $\mu\text{g}/\text{m}^3$



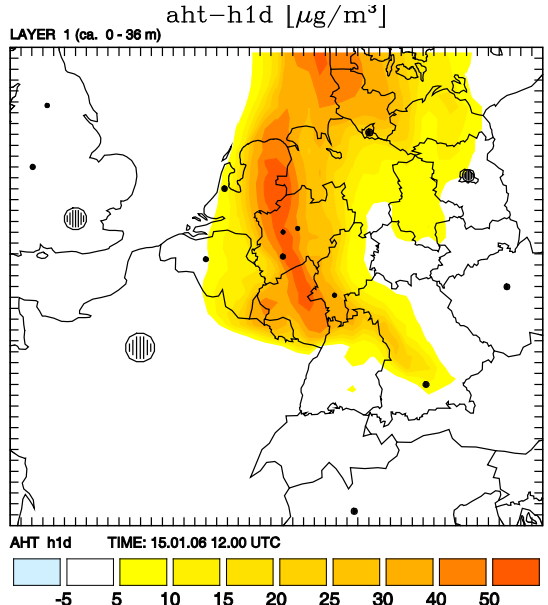
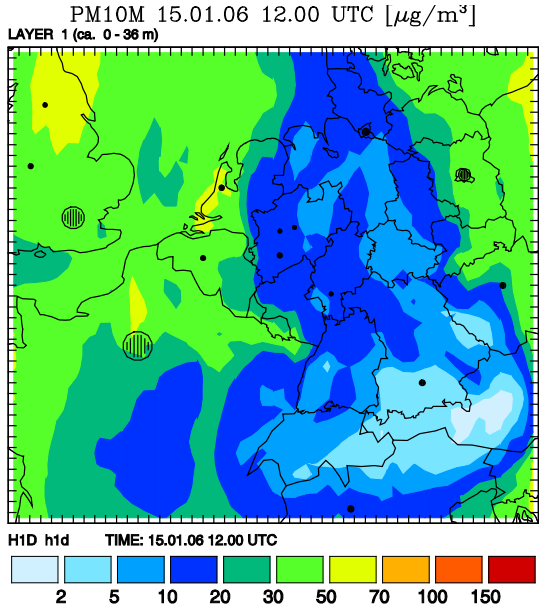
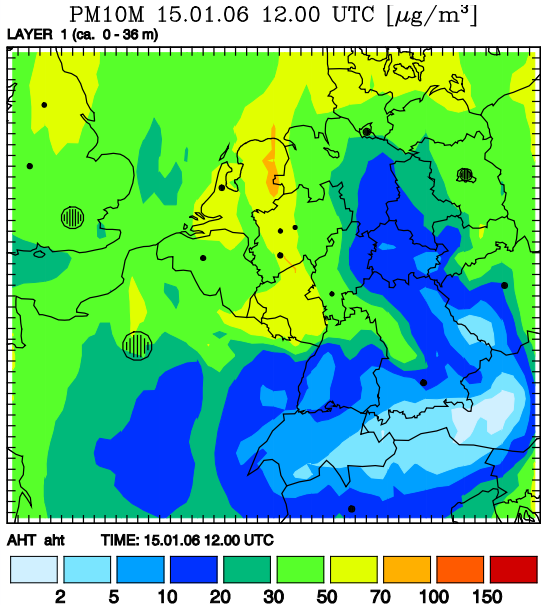
ACHA 2002 TIME: 10.01.02 18.00 UTC

SPECIFIC EPISODES: PM10, Jan 15, 2006

Base Case

Scenario: no Emi-GER

Base - noEmi-GER



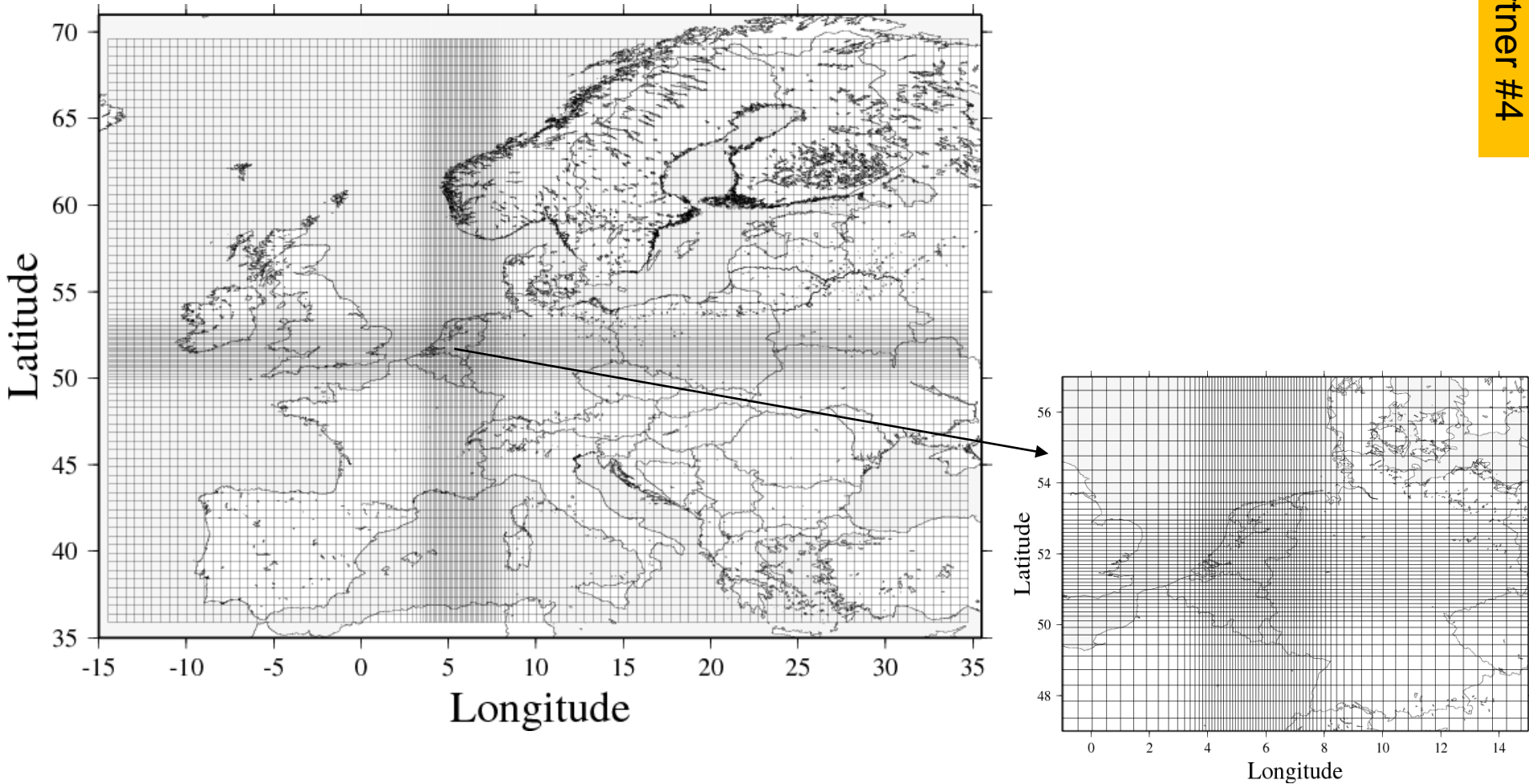
Transport dominated episode over North-Rhine-Westphalia, PM10 concentrations in NRW mainly due to inflow from south

An aerial photograph of a dense urban residential area, likely in a city like Beijing. The image shows numerous high-rise apartment buildings with balconies, arranged in a grid-like pattern. The buildings are mostly light-colored, possibly white or light grey, with some darker accents. The sky is a pale, hazy blue. A semi-transparent white rectangular box is overlaid on the center of the image, containing the text 'CHIMERE zooming' in a large, bold, black sans-serif font.

CHIMERE zooming

Example of « zooming » mesh over BENELUX with CHIMERE

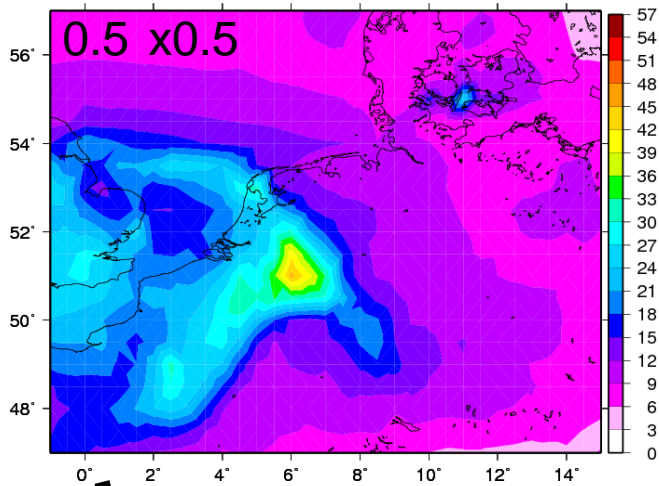
Refine the grid from 0.5 to 0.1 resolution over a specific region



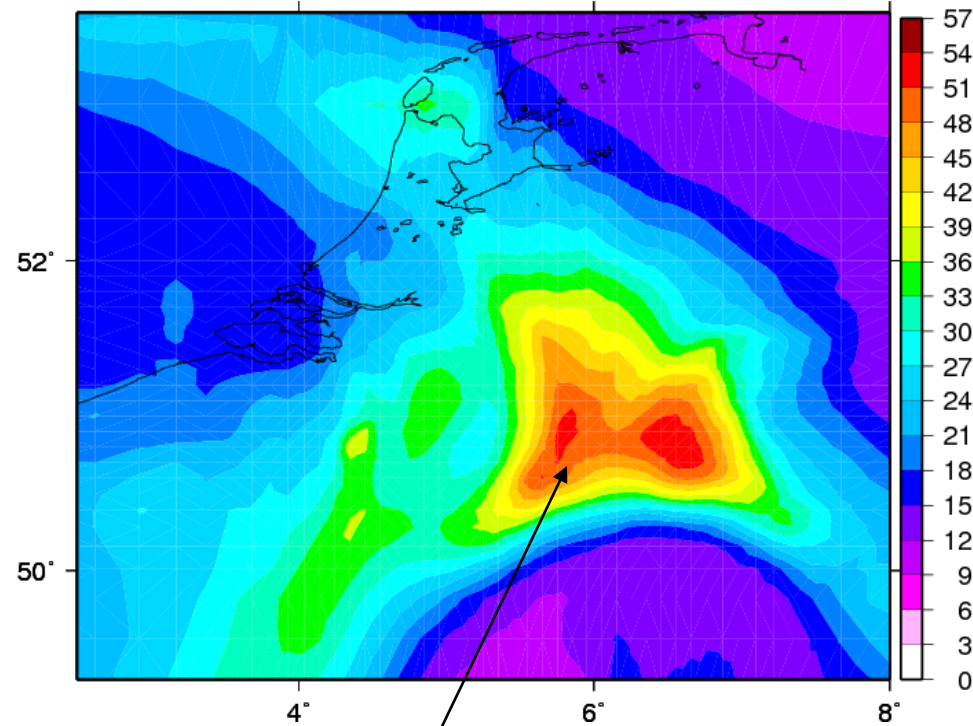
Guillaume Siour (INERIS/LISA/ADEME), Bertrand Bessagnet (INERIS)
Laurent Menut (LMD/IPSL-CNRS), Frédéric Meleux (INERIS), Laurence Rouïl (INERIS)

PM10 concentrations on 8 August 2003 [16:00]

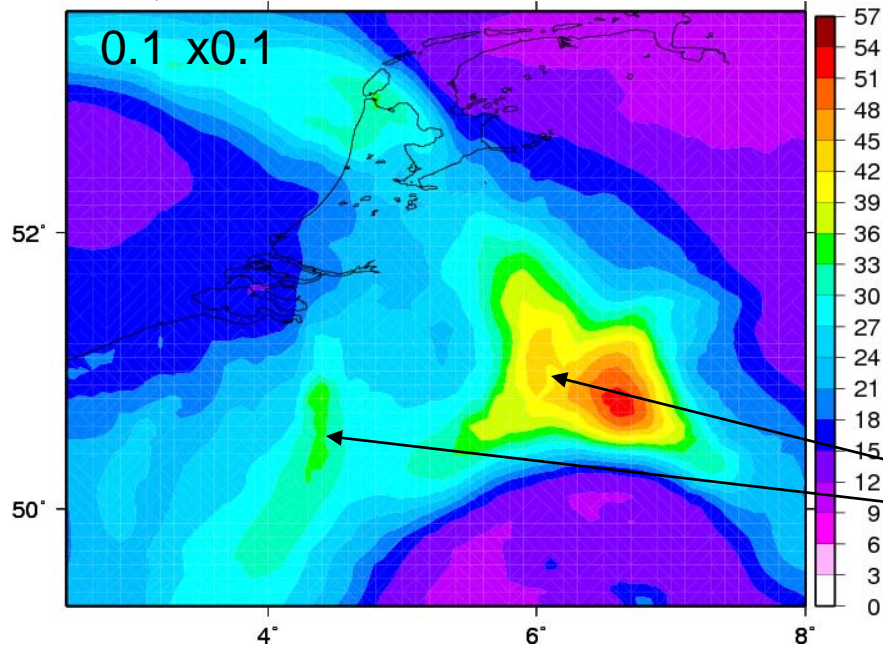
« zooming approach »
stretched mesh from 0.5 to 0.1

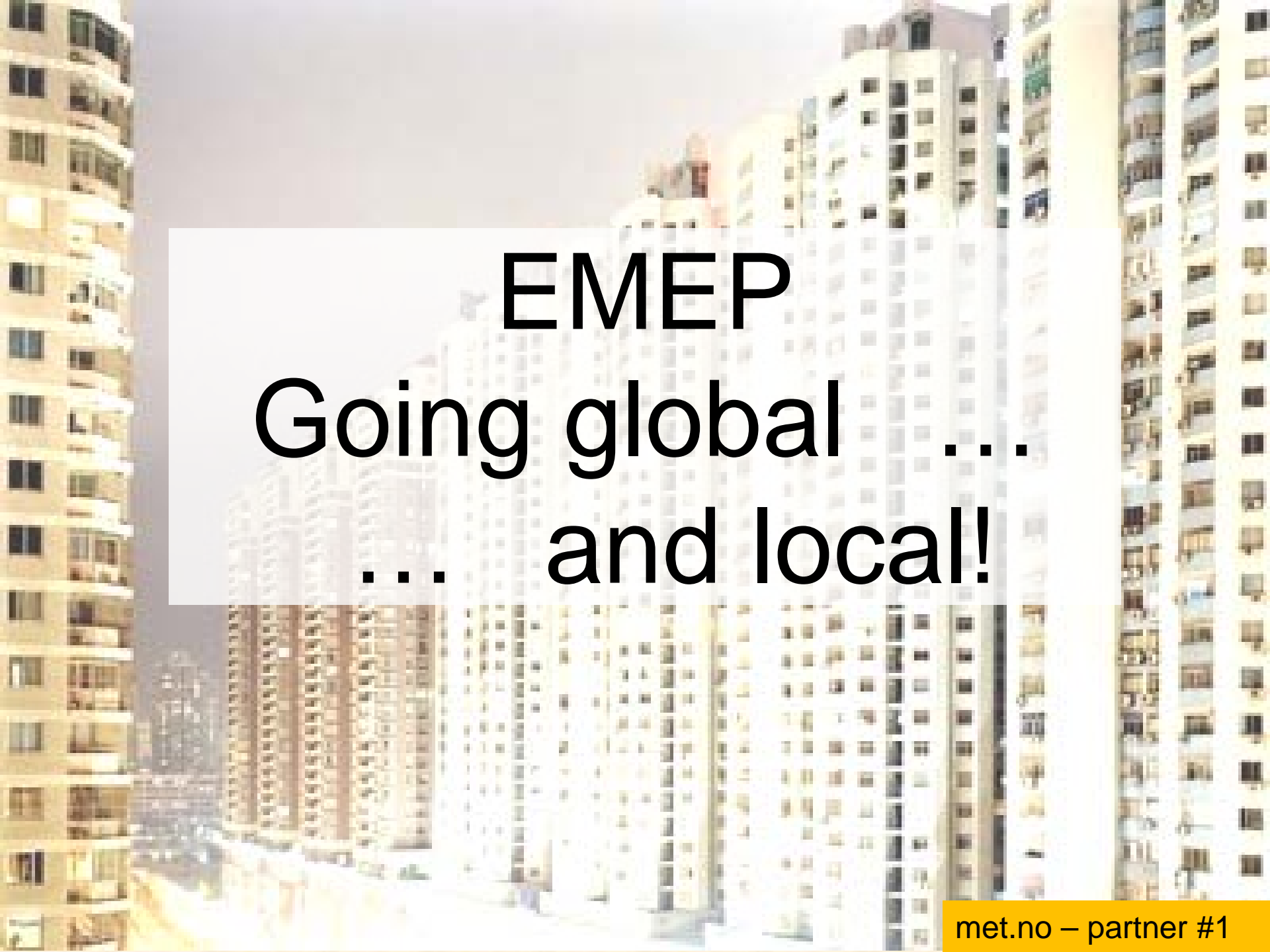


Regular coarse 0.5 to nest 0.1
resolution domain (1 way nesting)



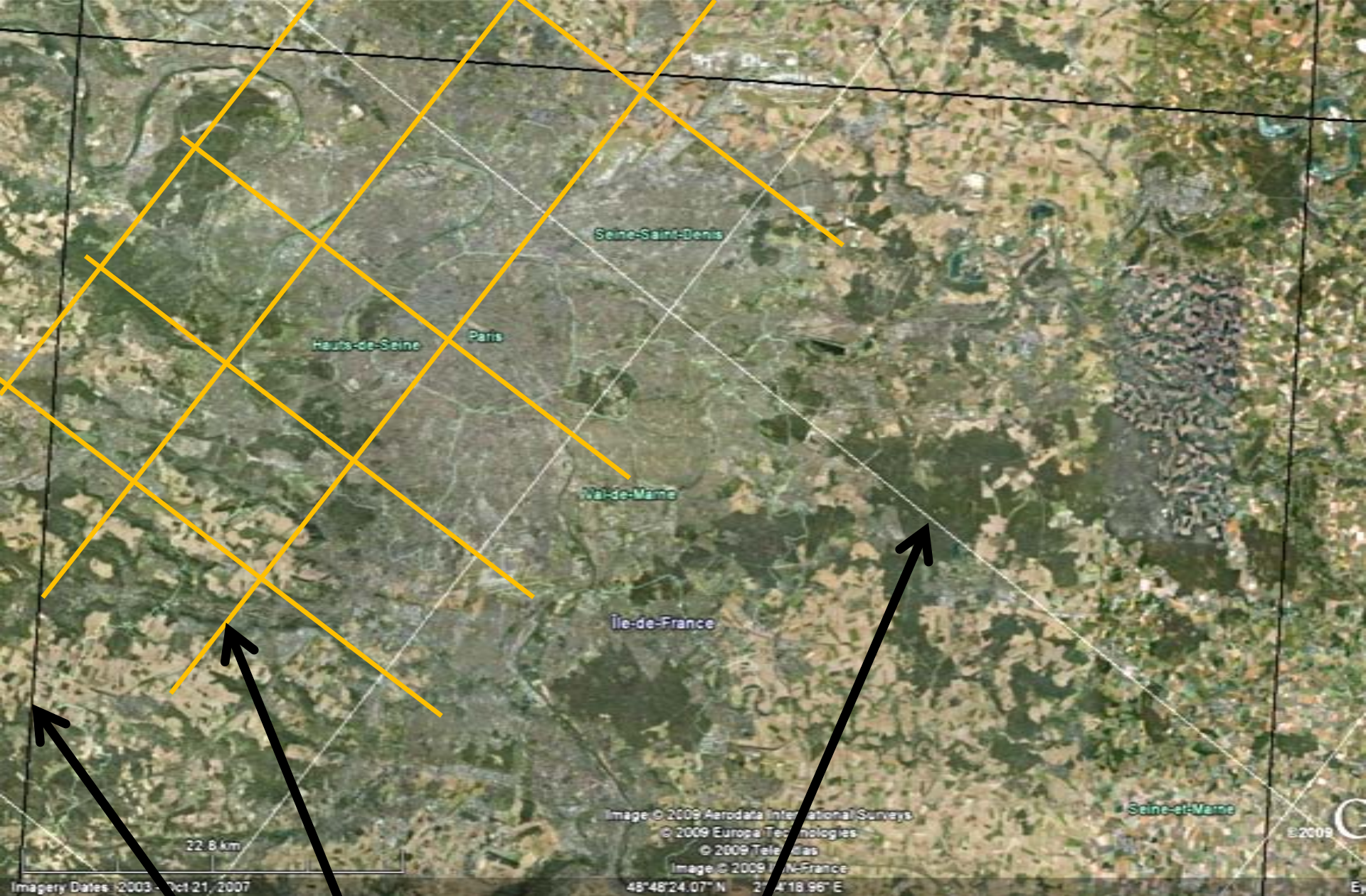
More details in the « zooming »
approaches





EMEP

Going global and local!



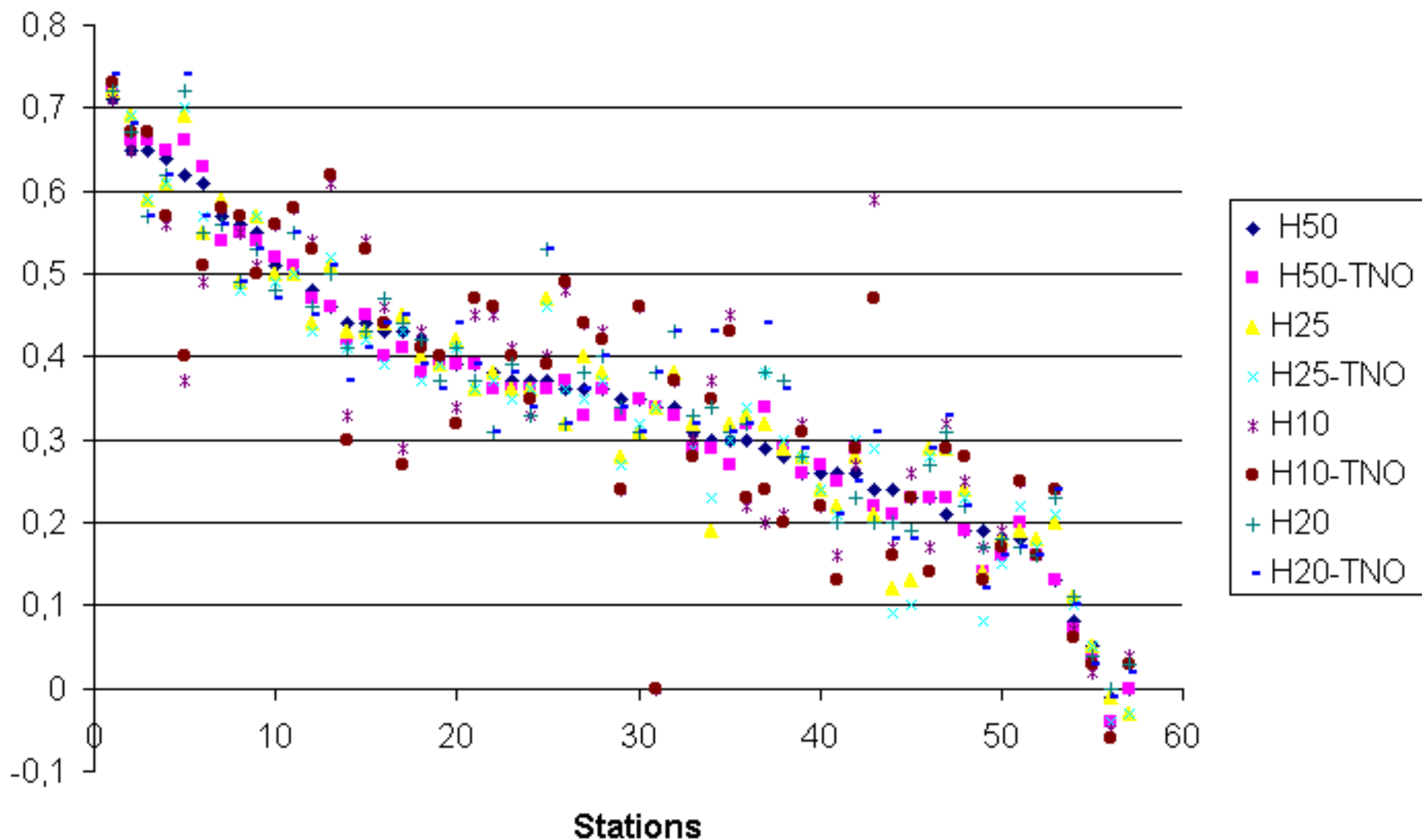
“H10”

Official EMEP grid (50x50 km², Europe)

Global EMEP grid (1x1 degree, global coverage)

metno - partner #1

Temporal correlation sulfate wet deposition



From Hilde Fagerli (met.no)

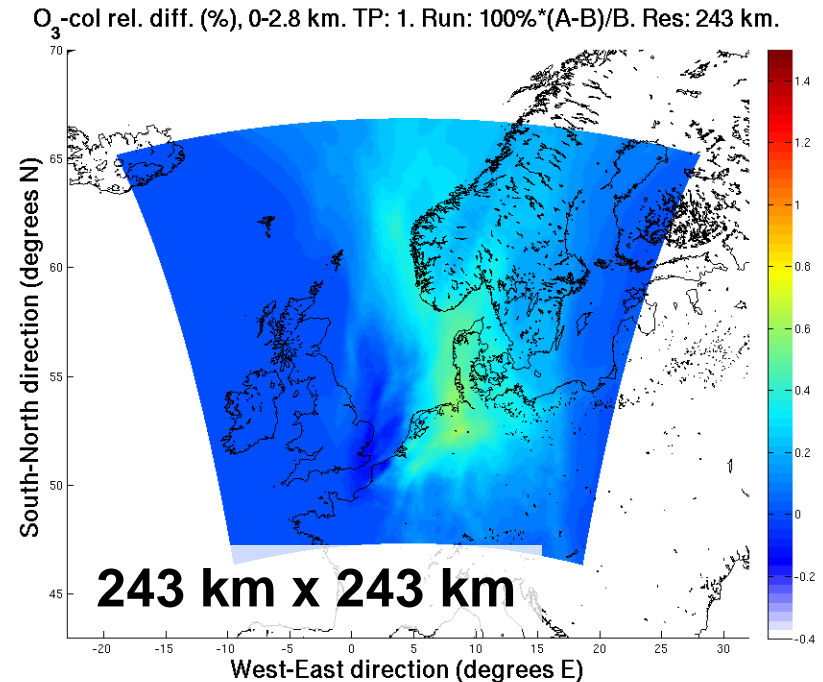
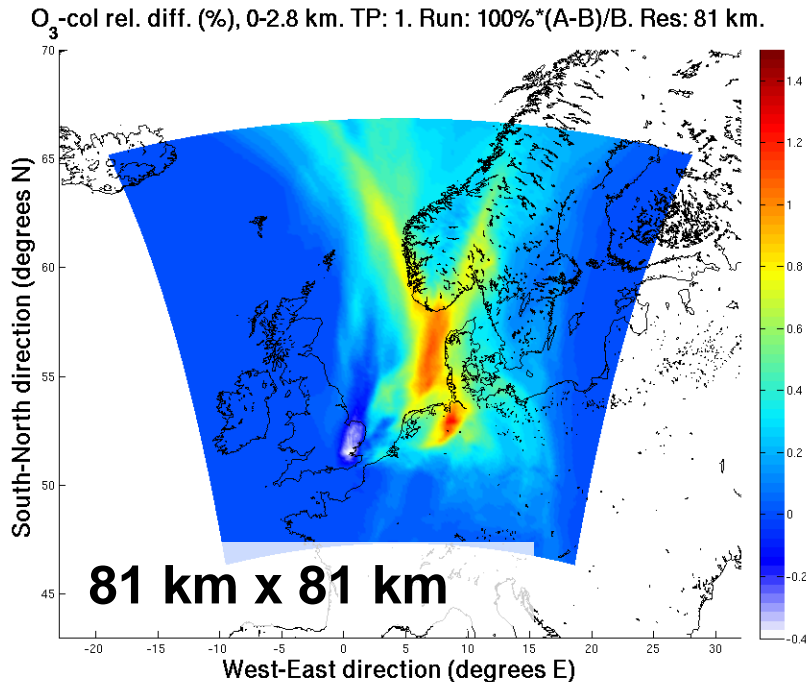
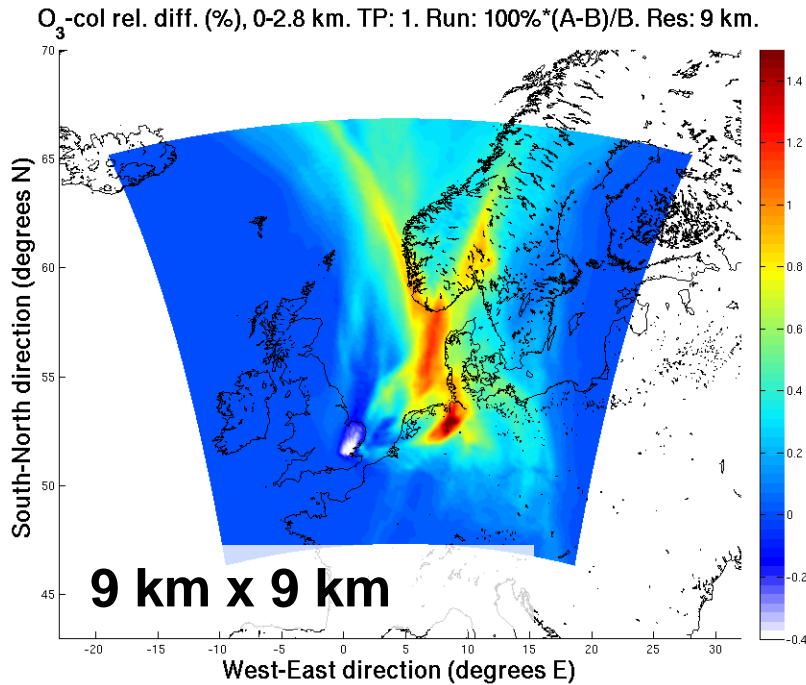


WRF-chem scale interaction

Øivind Hodnebrog (UiO)
 Frode Stordal (UiO)
 Terje Berntsen (UiO)

O₃ changes caused by London emissions (%)

July 23 – August 1, 2003



A few thoughts / way forward

- Typical resolution of global models is increasing
- Domains of some local and regional models increase
- Nesting/zooming beneficial for computational reasons
- One-way nesting vs. two-way nesting
 - does it really matter? The answer depends on resolution and the scientific question to be addressed
- Do we need to couple different models?
 - ... or should we rather spend resources on nesting and zooming within the same model?
- Inter-comparisons and ensemble studies (e.g. trends)
 - need to find the causes of differences
 - is the result of the ensemble more robust?
 - improvement of model formulations and input data

Last slide

- **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 (emissions, observations, modelling trends, bridging of scales)
- starting **interaction** between the different scale ‘communities’
- please visit <http://wiki.met.no/cityzen/start>