

Urban- and regional scale air quality modelling with AURORA

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VITO – Integrated Environmental
Studies



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Table 2.3. Comparison of air quality monitoring and dispersion modelling as tools for assessing air quality

Task	Relevance to:	
	Monitoring	Modelling
Assessing true concentrations	High	Low ^a
Alert systems	High	Low
Assessing variability in time	High	High
Assessing variability in space	Low ^b	High
Assessing concentrations in future	Low	High
Source apportionment	Low	High

^a Modelled results should always be compared with some measured values to assure that the model is reliable and the input data correct.

^b Increasing the number of monitors or samples can improve the spatial resolution and coverage of the monitoring network.

Monitoring ambient air quality for health impact assessment.

WHO regional publications, European series, no. 85, 1999.



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3 types of AURORA applications :

} → ASSESSMENT

→ FORECAST

→ SCENARIO

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Monitoring ambient air quality for health impact assessment.

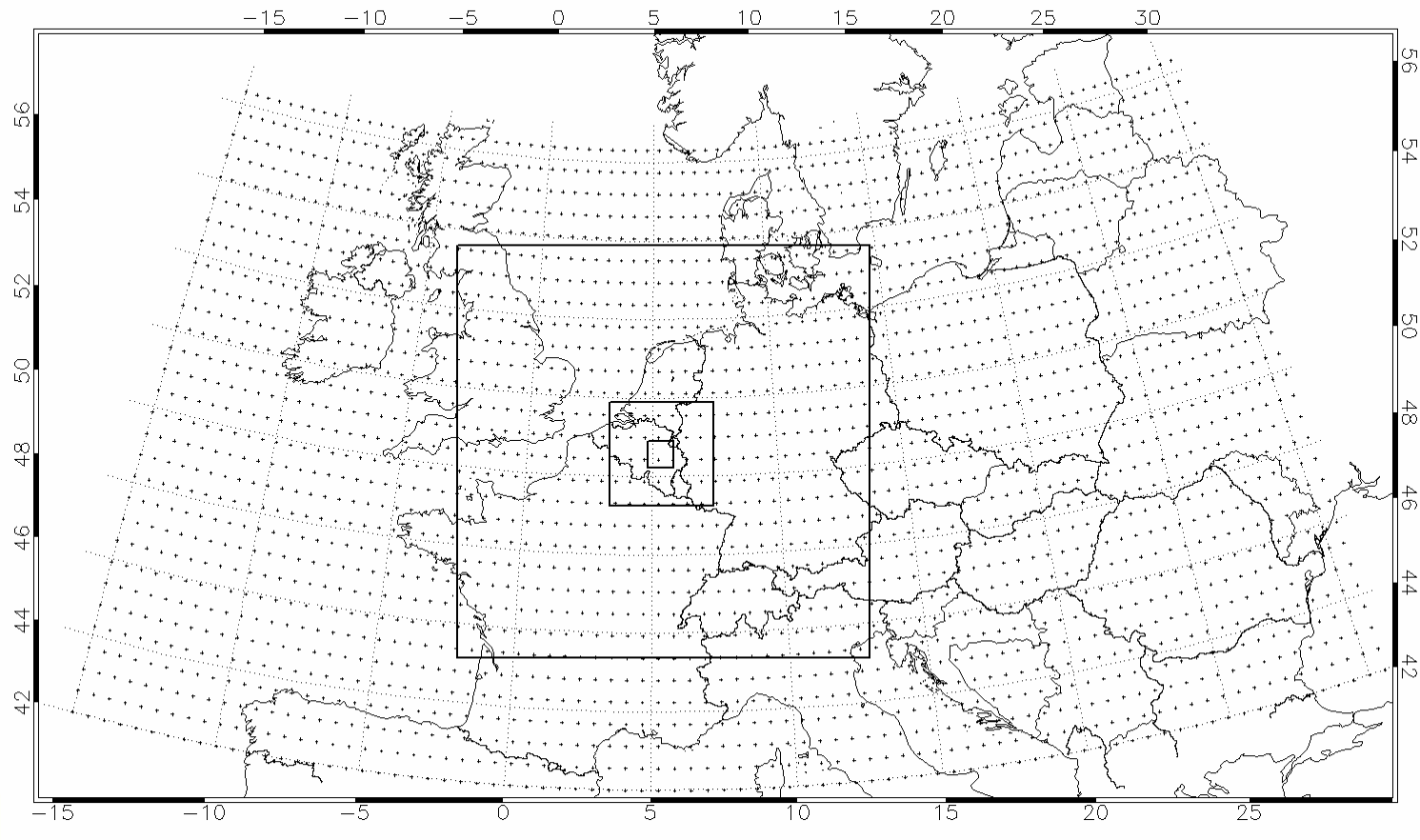
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AURORA = Air quality modelling in Urban Regions using an Optimal Resolution Approach

- 3-dimensional Eulerian chemistry-transport model
- different scales : regional down to urban scale
- meteorology : ARPS model (wind, turbulent diffusion, temperature, ...)
- emissions : anthropogenic (traffic, industry, domestic combustion, ...) and biogene origin
- transport : Walcek advection, Crank-Nicholson diffusion
- chemistry :
 - Carbon-Bond IV gas-phase chemistry with isoprene, limited PM
 - CACM gas-phase mechanism and MADRID2 aerosol module
- output : hourly gridded pollutant concentrations (O_3 , PM_{10} , $PM_{2.5}$, NO_2 , benzene, PAH, ...)





principle of nesting :
multiple runs needed going from big domain at coarse resolution
to domain of interest at high resolution



meteorology :

ECMWF, NCAR,
MM5, ...

ARPS 30 km

ARPS 10 km

ARPS 3 km

ARPS 1 km

chemistry-transport :

Chimere, TM, EURAD,
BelEuros, ...

AURORA 30 km

AURORA 10 km

AURORA 3 km

AURORA 1 km

PROMOTE - ESA atmospheric GMES service :

- air quality forecast
- air quality assessment
- scenario calculations



Benefits of Urban Green Space (BUGS) – FP5 :

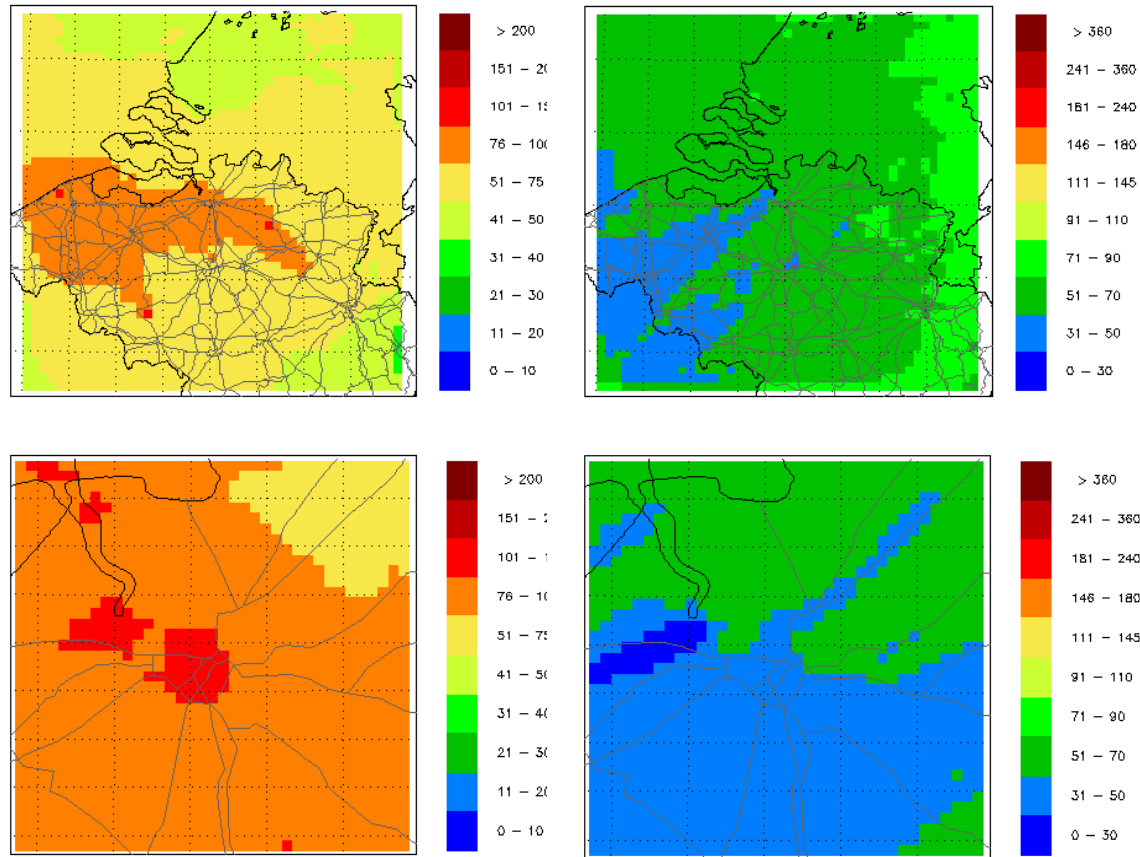
- scenario calculations





PROMOTE - air quality forecast

- daily forecast for today and tomorrow
- Belgium at 5 km; Cities of Brussels, Antwerp, Ghent, Liege and Charleroi at 1km
- pollutants : O_3 , NO_2 , PM_{10} , $PM_{2.5}$
- user : environmental agency IRCEL



PM_{10} – daily mean

O_3 , daily max



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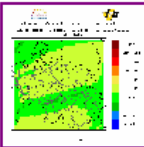
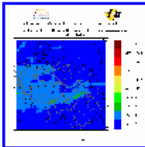
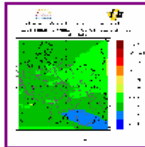
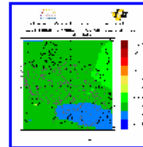
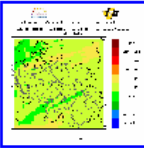
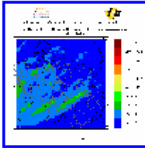
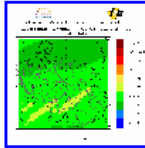
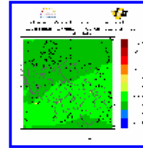
ESA project PROMOTE, PROtocol MOniTORing for the GMES Service Element - Microsoft Internet Explorer

Address: <http://www.gse-promote.org/>

PROMOTE Forecast

Last update : 21-04-2008



Latest PROMOTE forecast

	O3 daily max	NO2 daily mean	PM10 daily mean	PM2.5 daily mean
21-04-2008				
22-04-2008				

Zoom to

- [Belgium 5km](#)
- [Antwerp 1km](#)
- [Brussels 1km](#)
- [Charleroi 1km](#)
- [Ghent 1km](#)
- [Liege 1km](#)

<http://www.gse-promote.org/>

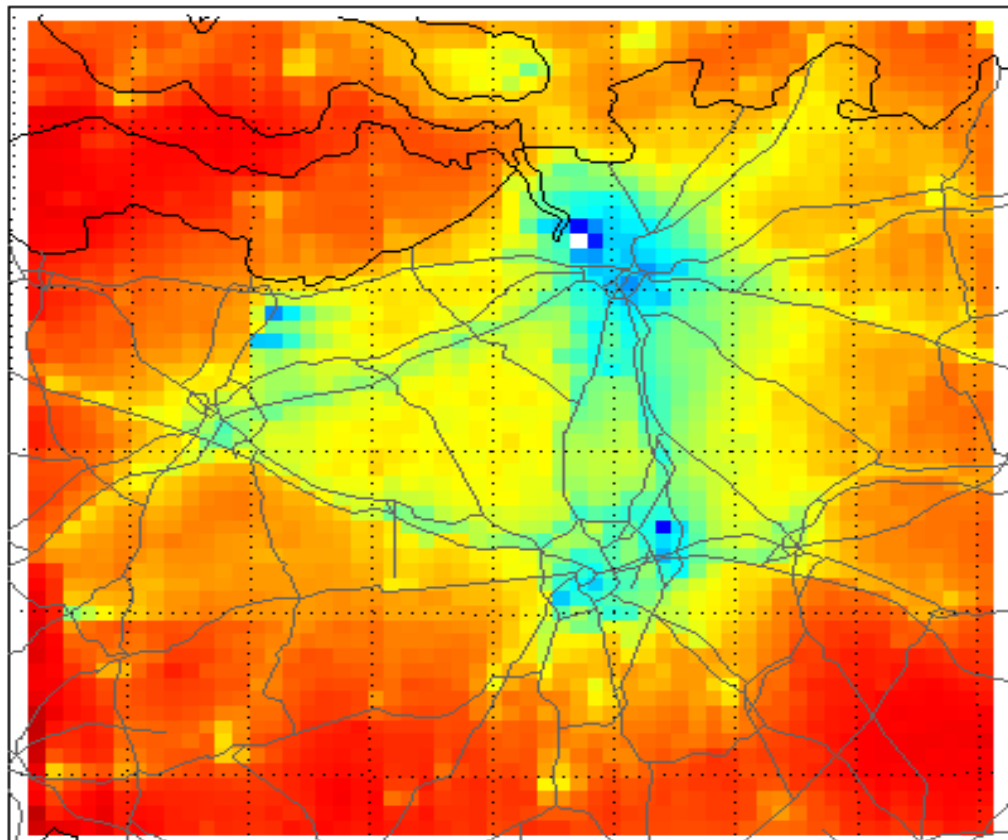


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PROMOTE - air quality assessment

- focus :
 - long simulation periods :
 - EU directives
 - long-term human exposure to air pollution
 - extraction of air quality indicators
 - high spatial resolution :
 - discrimination between urban, industrial, rural, ... areas
- users : cities, regional authorities, ...

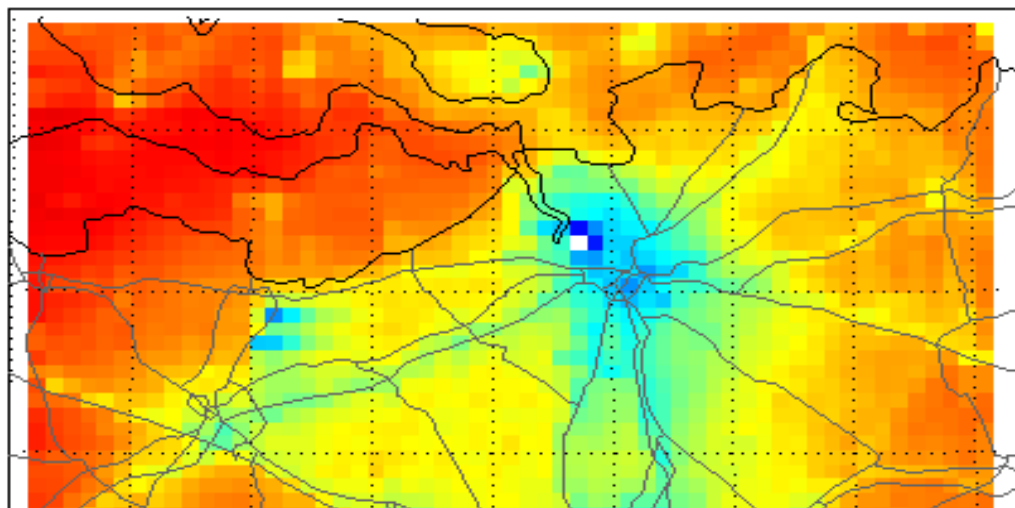




- Antwerp – Brussels – Ghent
- horizontal resolution : 2km
- year 2004, hourly resolution

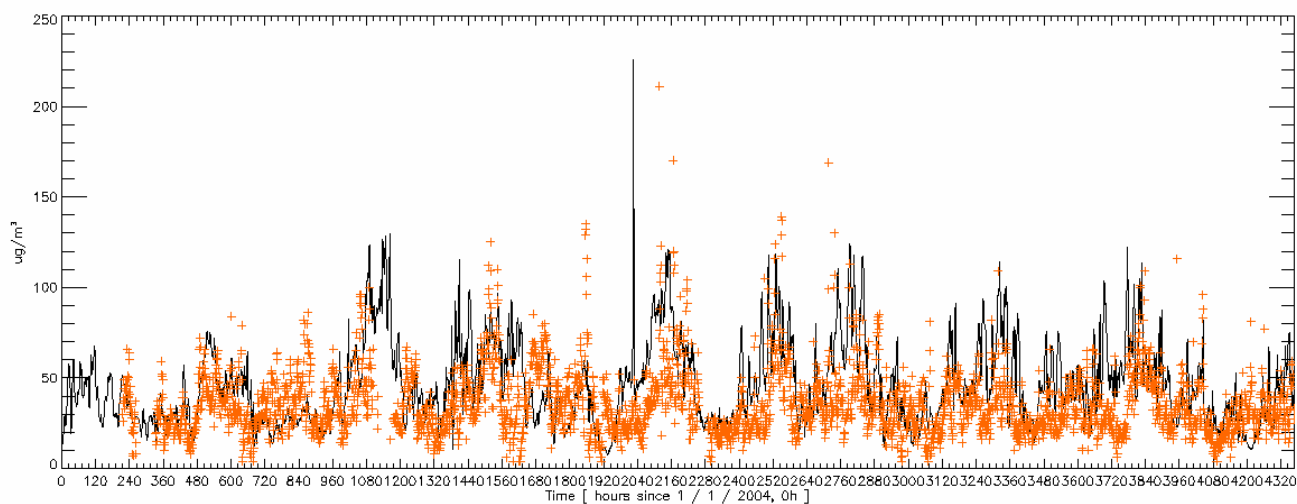


- Antwerp – Brussels – Ghent
- horizontal resolution : 2km
- year 2004, hourly resolution



Aurora :: Timeseries Plot :: 2km resolution

Period : 1/1/2004:0 - 30/6/2004:23 Pollutant : PM10 Location : Antwerpen Resolution : hourly values



17.3769

PROMOTE - air quality assessment



Cities :

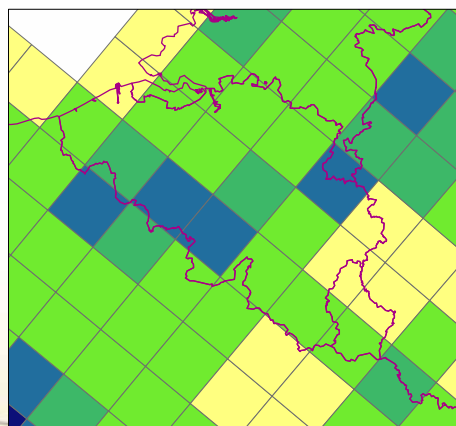
- Europe : Brussels, Prague, Rotterdam, Milan, ...
- Irkutsk (RU), Shenyang (PRC), Yangzhou (PRC), Beijing (PRC)

Emission data :

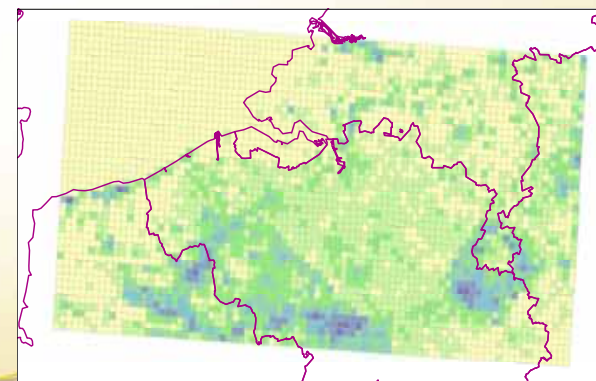
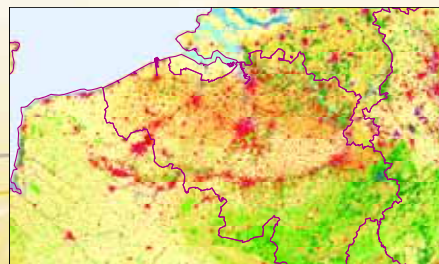
- Either local data (to be provided by the city in question)

or

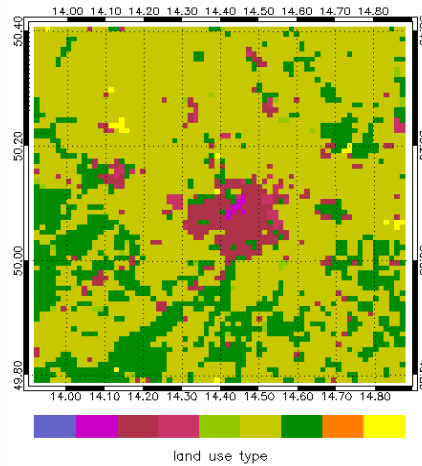
- E-MAP (Emission MAPPING) GIS tool :
downscale of large-scale emissions with spatial proxy data



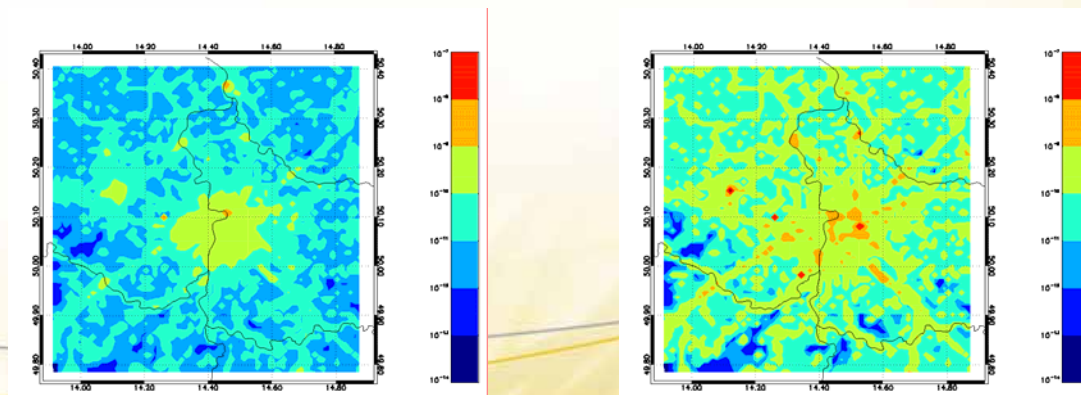
EMEP database



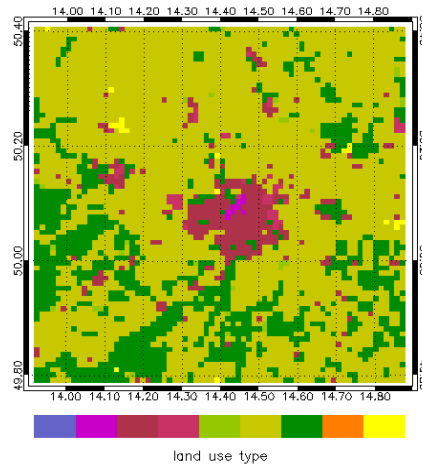
Prague,
70x70km,
1km resolution



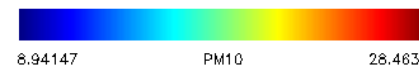
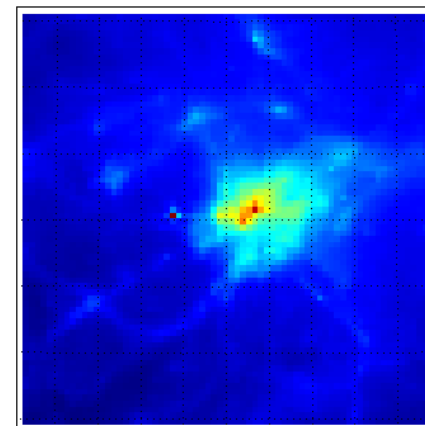
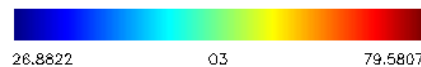
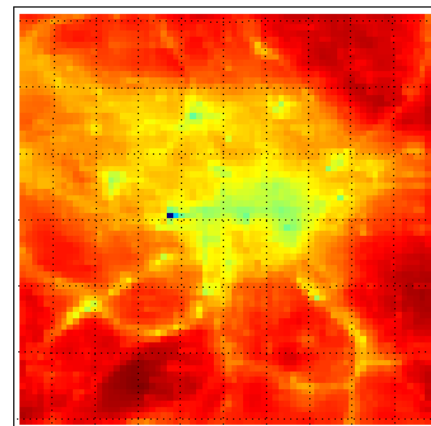
PM10 and NOx emission fields (instantaneous)



Prague,
70x70km,
1km resolution



O₃ and PM₁₀ concentration field [$\mu\text{g}/\text{m}^3$]



BUGS – vegetation scenario



- Antwerp urban area
- change vegetation in the center of the city of Antwerp, effect on O_3
Land use change > effect on air temperature > O_3 formation



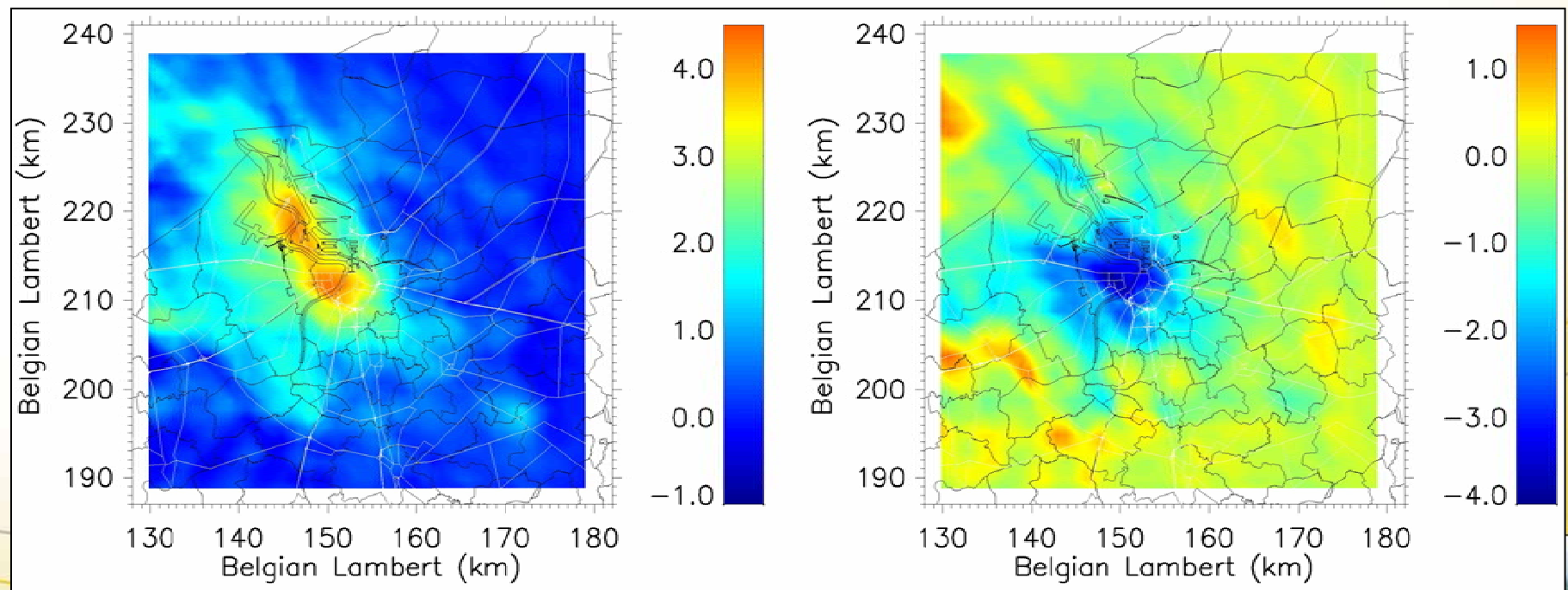
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vegetation *decreased* by 50 %

vegetation *increased* by 50 %



(colour code ~ % O_3 concentration change)