

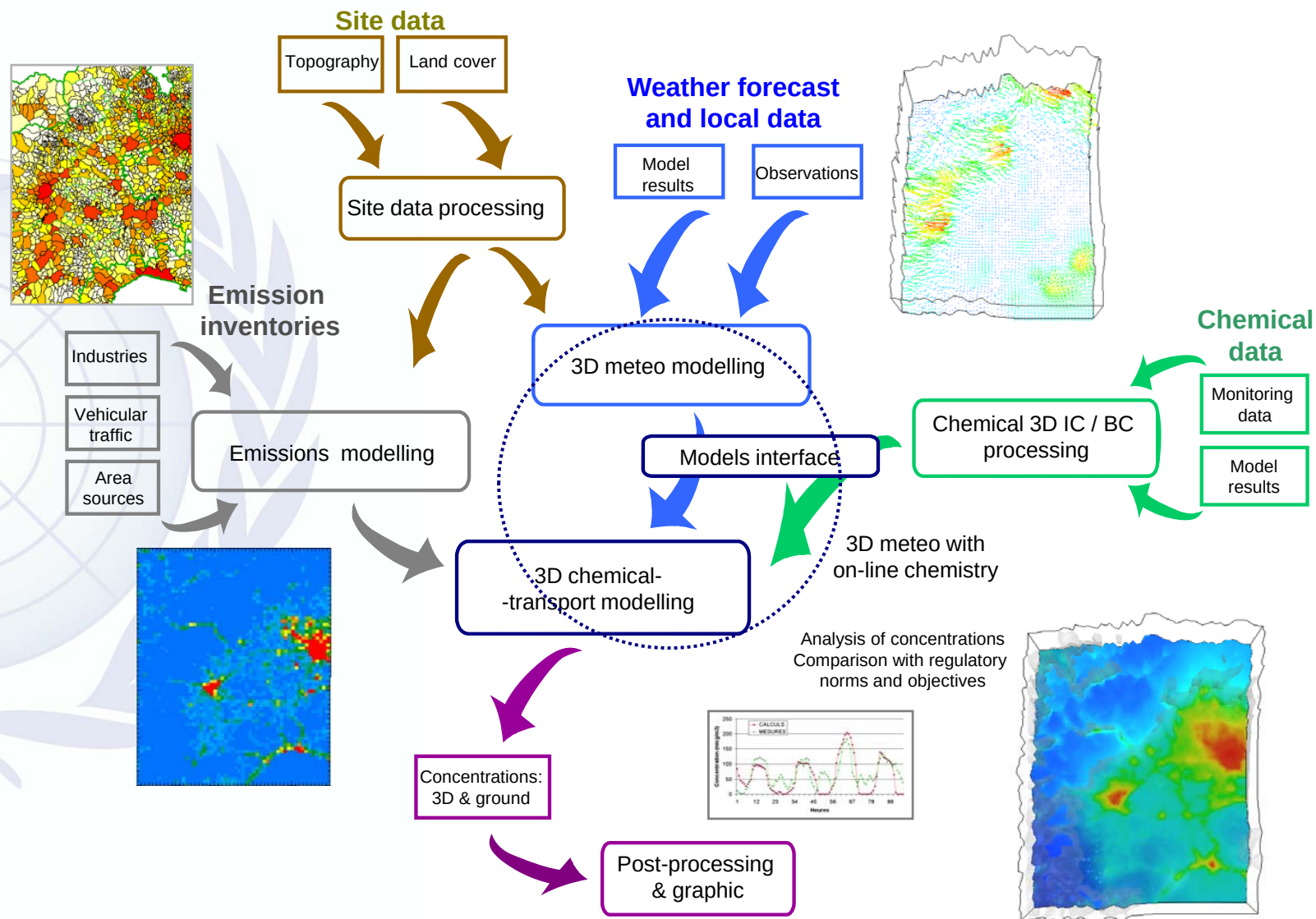
AREP
GAW



AQM data feeding

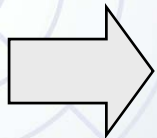
WMO
OMM

An Air Quality Modelling System



AQM input data sets

- Meteorology
- Emissions
- Geographic data
- Chemical boundary conditions



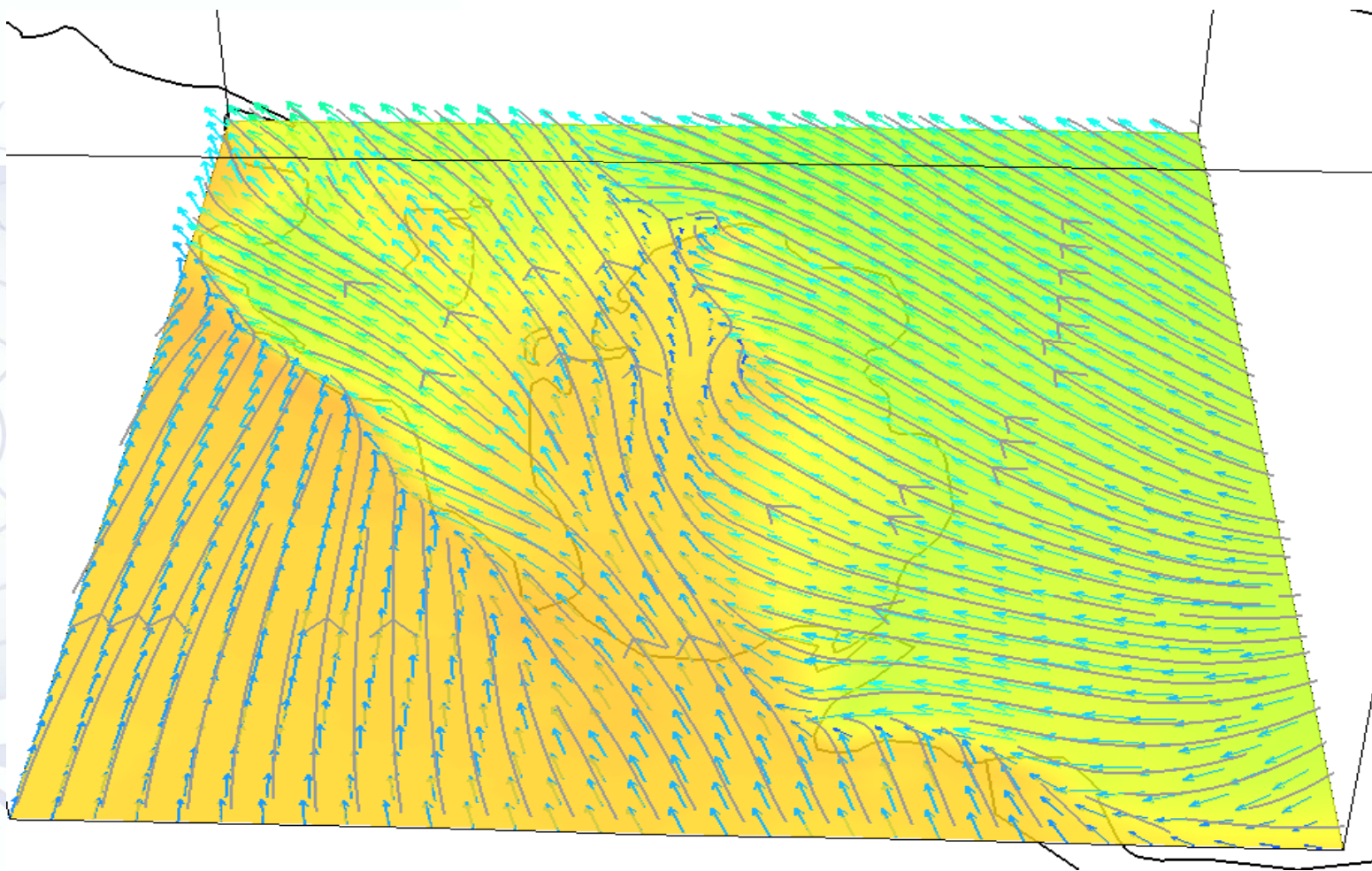
Data sources & treatments

AQM input data sets

- Meteorology
- Emissions
- Geographic data
- Chemical boundary conditions

Hi-resolution meteorology

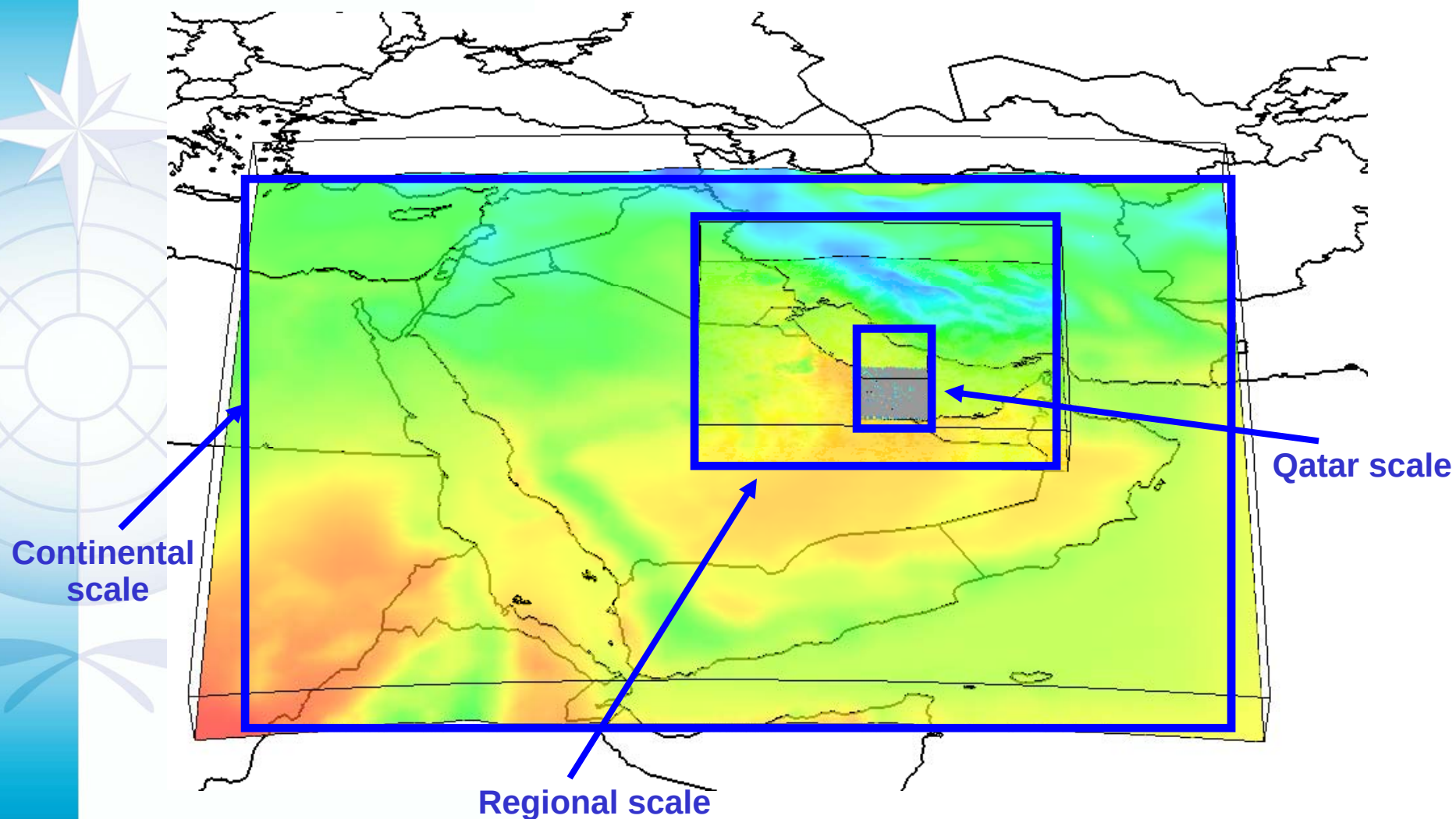
Example: Qatar AQ forecast system



3 km resolution

Multi-scale meteorological model

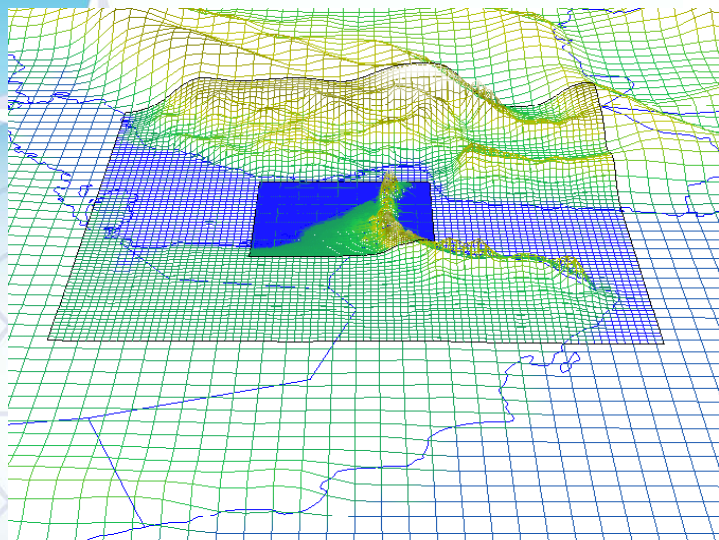
Example: MM5 for Qatar AQ forecast system



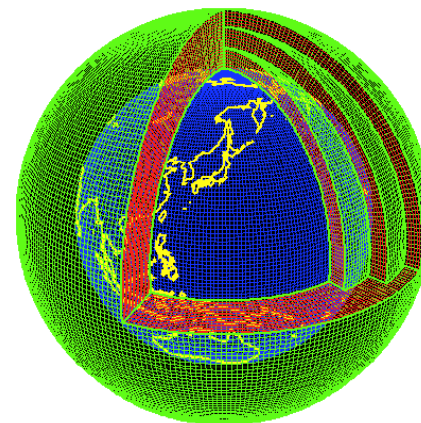
Resolution: 30 → 10 → 3

Input data

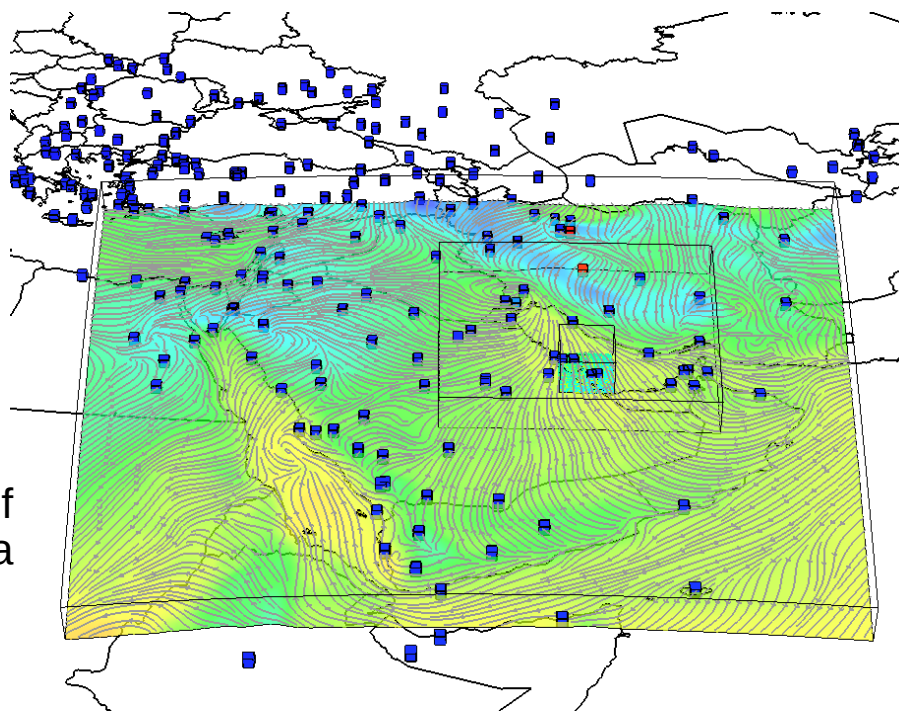
Orography & land-use



Global



Assimilation of
synoptic met data



Diagnostic meteorology - Input

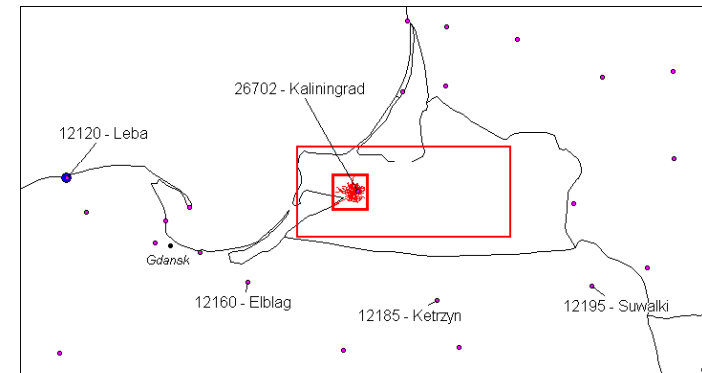
Example: Kaliningrad (Russia)

Ground level

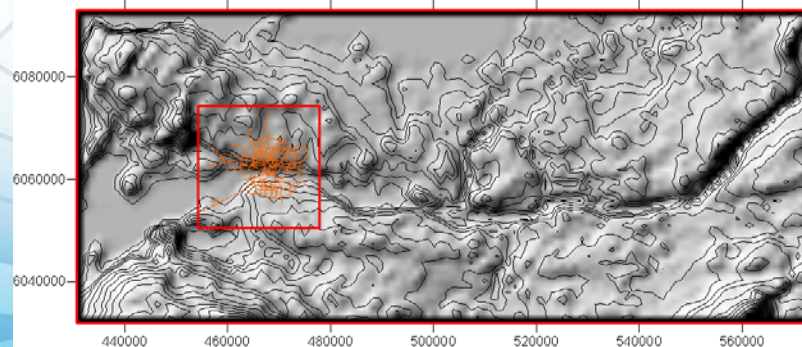
- SYNOP and METAR stations
- temperature, wind speed and direction, total cloud cover (for radiation estimation)

Upper-air soundings

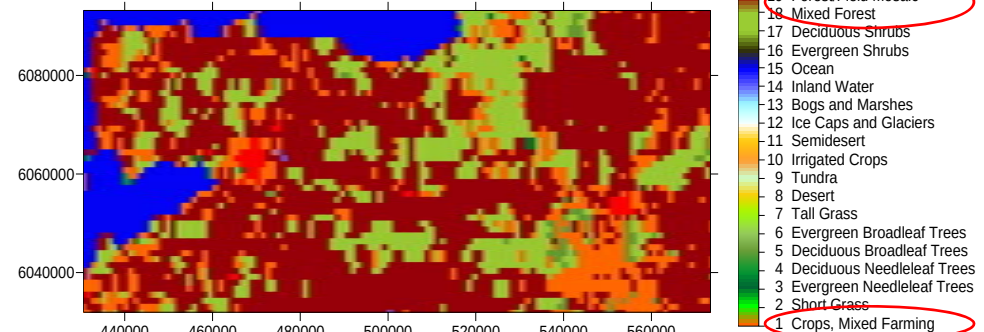
- temperature, wind speed and direction



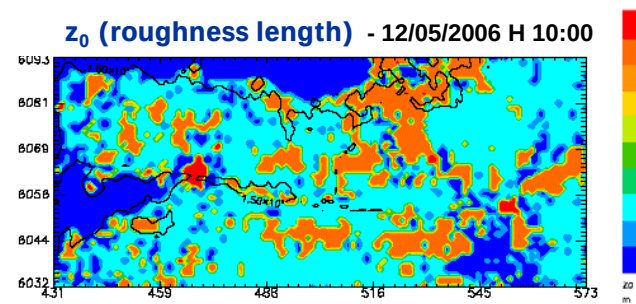
Orography



Land-use



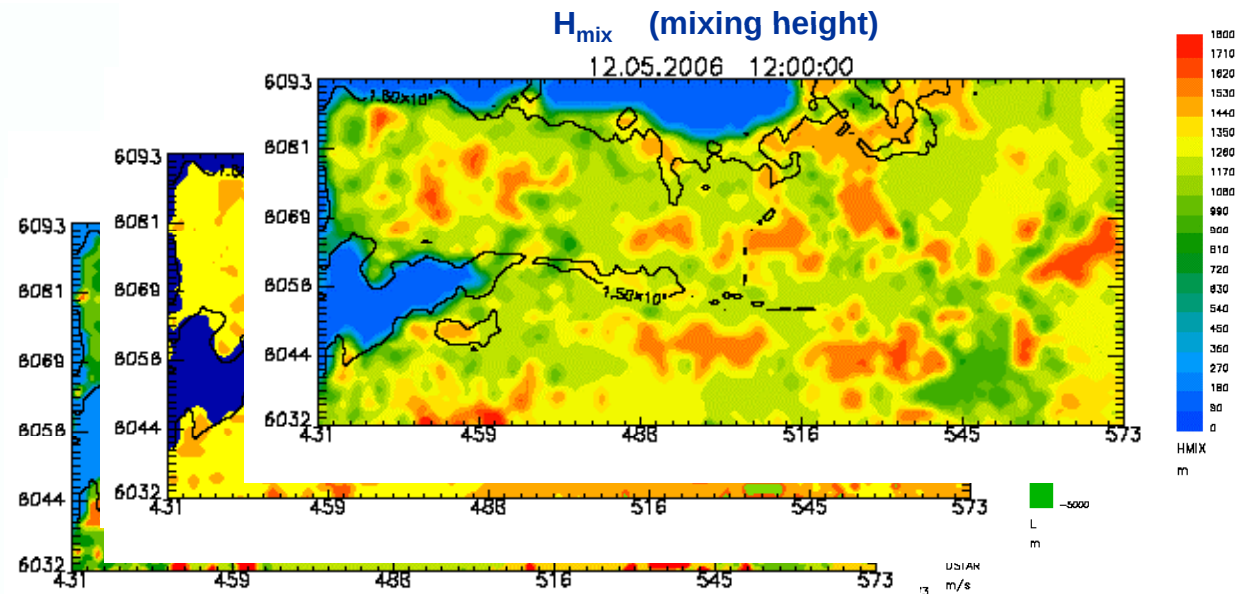
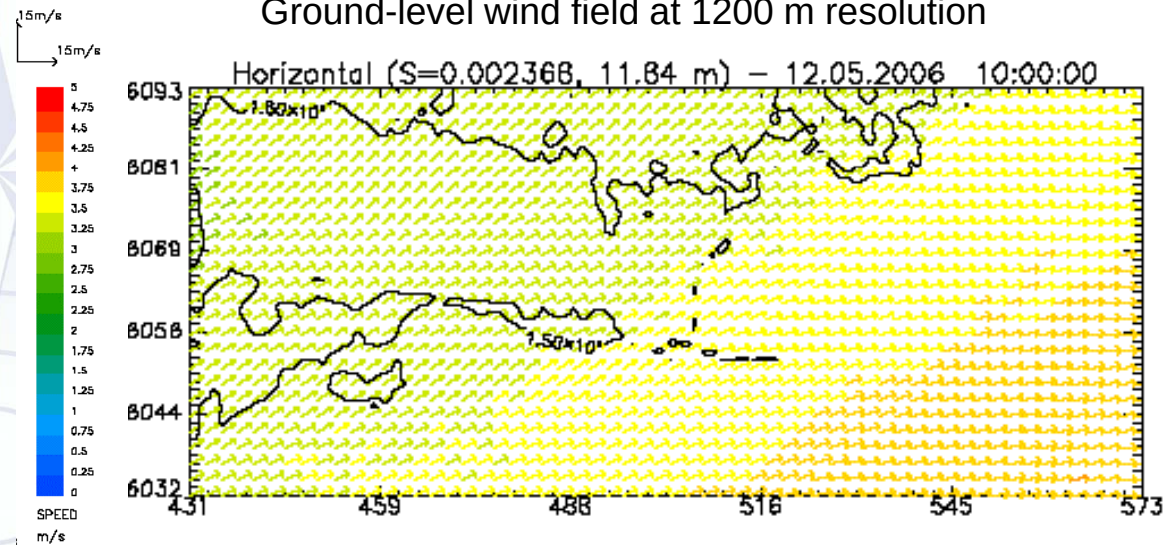
z_0 (roughness length) - 12/05/2006 H 10:00



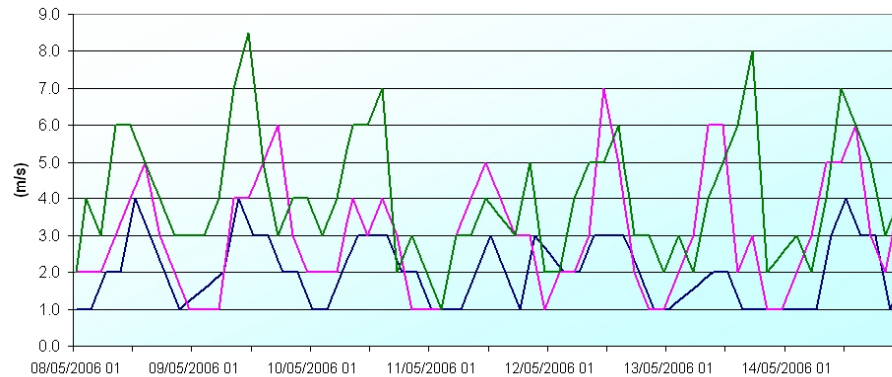
Diagnostic meteorology - Output

Example: MINERVE/SWIFT Kaliningrad (Russia)

Ground-level wind field at 1200 m resolution

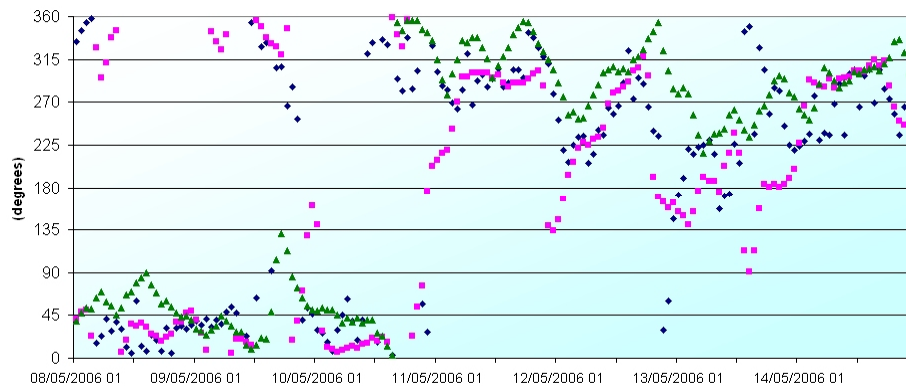


Quality of input data



Wind Speed (May 2006, 8th - 14th)

— Kaliningrad — Ketrzyn — Suwalki



Wind Direction (May 2006, 8th - 14th)

◆ Kaliningrad ■ Ketrzyn ▲ Suwalki

- Consistency
- Quality check
- Missing data

Diagnostic vs. prognostic

Diagnostic

- Closely related to observations
- “Dense” network
- Completeness & consistency among variables ...?
- Computationally cheap

Prognostic

- Computationally intensive
- “More physics”
- Inter-variable and inter-grid consistency
- Forecast

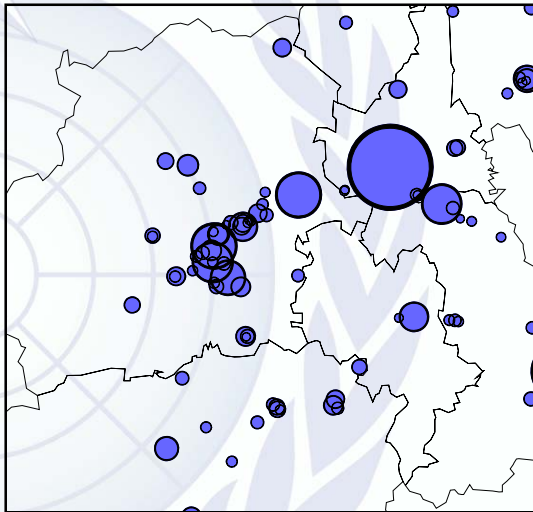
AQM input data sets

- Meteorology
- Emissions
- Geographic data
- Chemical boundary conditions

Emission inventory

Sources geometries ...

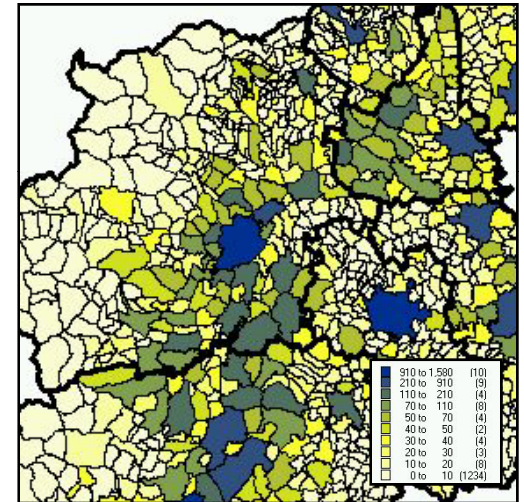
... point



... line



... area



- Data availability
- Scale

Activities classification scheme

Extract from EEA CORINAIR 97 nomenclature tree

01	Combustion in energy and transformation industries
02	Non-industrial combustion plants
03	Combustion in manufacturing industry
04	Production processes
05	Extraction and distribution of fossil fuels and geothermal energy
06	Solvent and other product use
07	Road transport
08	Other mobile sources and machinery
09	Waste treatment and disposal
10	Agriculture
11	Other sources and sinks

07 01	Passenger cars
07 02	Light duty vehicles < 3.5 t
07 03	Heavy duty vehicles > 3.5 t and buses
07 04	Mopeds and Motorcycles < 50 cm ³
07 05	Motorcycles > 50 cm ³
07 06	Gasoline evaporation from vehicles
07 07	Automobile tyre and brake wear

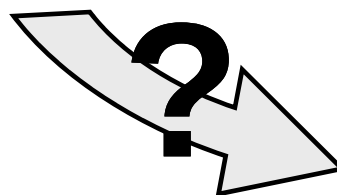
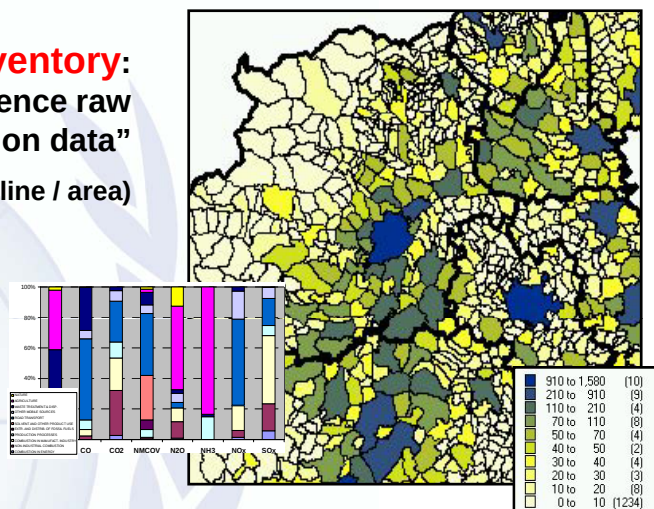
07 01 01	Highway driving
07 01 02	Rural driving
07 01 03	Urban driving

11 01	Non-managed broadleaf forests
11 02	Non-managed coniferous forests
11 03	Forest and other vegetation fires
11 04	Natural grassland and other vegetation
11 05	Wetlands (marshes - swamps)
11 06	Waters
11 07	Animals
11 08	Volcanoes
11 09	Gas seeps
11 10	Lightning

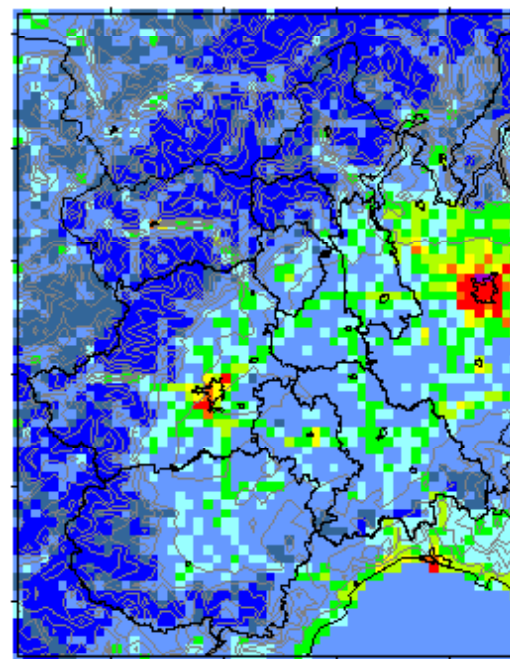
11 02 04	Norway spruce
11 02 05	Sitka spruce
11 02 06	Other spruce
11 02 07	Scots pine
11 02 08	Maritime pine
11 02 09	Aleppo pine
11 02 10	Other pines
11 02 11	Fir
11 02 12	Larch
11 02 15	Other conifers
11 02 16	Soils (excluding CO ₂)

Model-ready emission input

Inventory:
“reference raw
emission data”
(point / line / area)

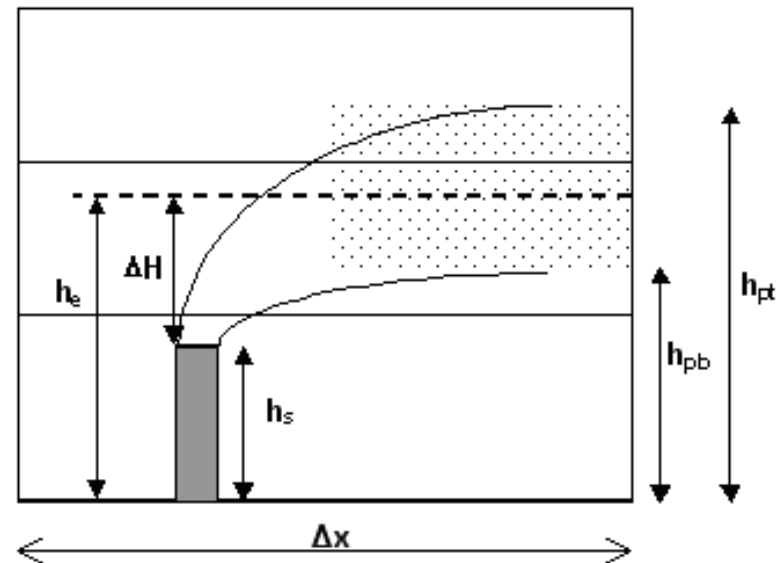


Model-ready input
(hourly, gridded,
speciated emissions)



Point sources

- Location
- Stack data (height, diameter, exit speed & temperature)
- Pollutants emission rates
- Plume rise
- Injection into (3D) modelling grid



Line sources

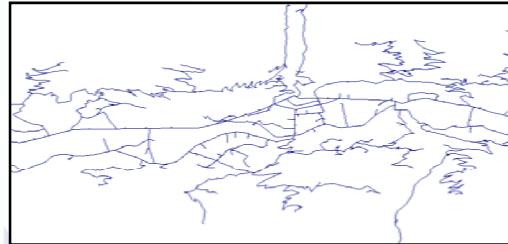
- Network geometry
- Pollutants emission rates
- Allocation (intersection) on the modelling grid

Traffic allocation model

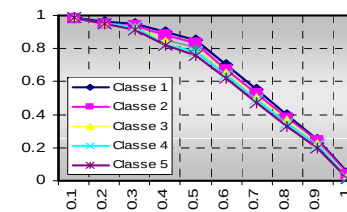
Traffic counts

	Classe 1	Classe 2	Classe 3	Classe 4	Classe 5
a	22	15	8	5	3
b	45	33	23	4	-
c	32	23	5	-	2
d	57	35	20	8	3
e	12	8	3	-	1
f	88	65	34	12	5
g	15	6	2	-	-
h	34	20	12	3	2
i	25	15	-	-	-
l	95	68	22	11	7
m	45	33	18	7	3
n	36	22	11	6	2

Road graph



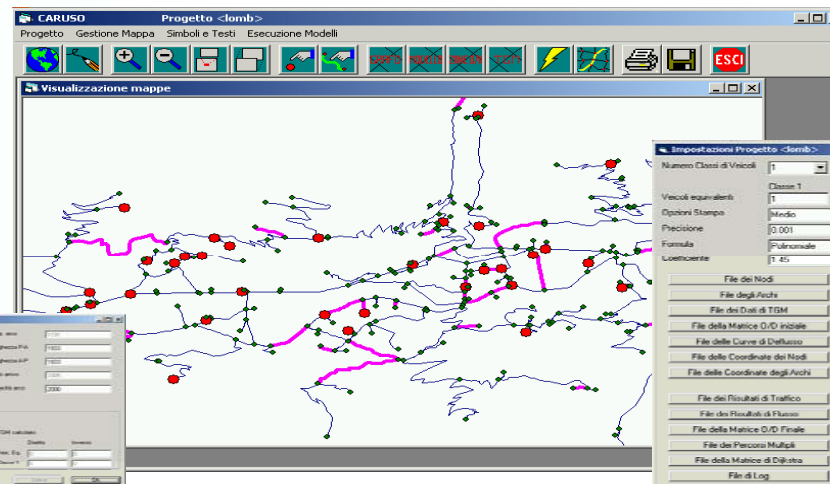
Flow curves



O/D matrix

	A	B	D	E	F	G	H
A		120	230	100	55		32
B	90		26		160	20	180
D	180	26		320	250	330	
E		48	320		120	40	60
F	55	160	230			80	250
G	74		320	70	80		25
H	45	170	20	120	220	25	

Traffic model



Impostazioni Progetto <clomb>

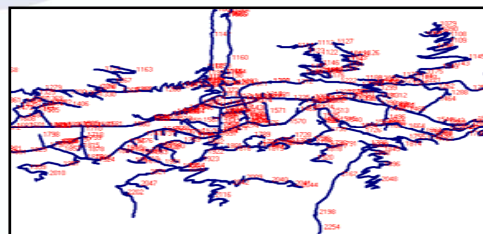
Numero Classi di Veicoli: 1
Classe 1: 1
Veicoli equivalenti: 1
Opzioni Stampa: [Menu]
Precisione: 0.001
Formula: Polinomiale
Coefficiente: 1.45

Numero Persone: 4
Numero Iterazioni: 10
Alfa: 0
Rapporto max: 1.3
Imposta Misure i unit: No

File dei Nodi: [File]
File degli Archi: [File]
File dei Dati di TGM: [File]
File della Matrice O/D iniziale: [File]
File delle Curve d'Influsso: [File]
File delle Coordinate dei Nodi: [File]
File delle Coordinate degli Archi: [File]
File dei Risultati di Traffico: [File]
File dei Risultati di Flusso: [File]
File della Matrice O/D Finale: [File]
File dei Percorsi Multipli: [File]
File della Matrice di Capacità: [File]
File di Log: [File]

[OK] [Cancel]

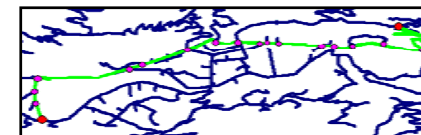
Fluxes and speeds



Calculated O/D matrix

	A	B	D	E	F	G	H
A		90	210	80	43		28
B	120		32		190	20	160
D	230	26		280	250	320	
E		51	290		120	30	43
F	90	160	250			85	210
G	70		280	40	70		21
H	32	150	30	129	300	100	

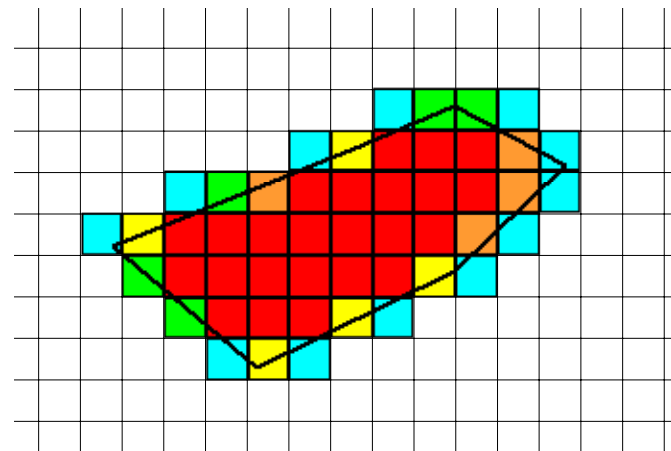
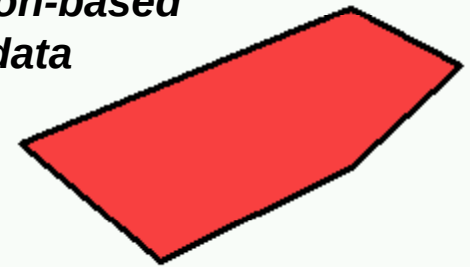
Paths



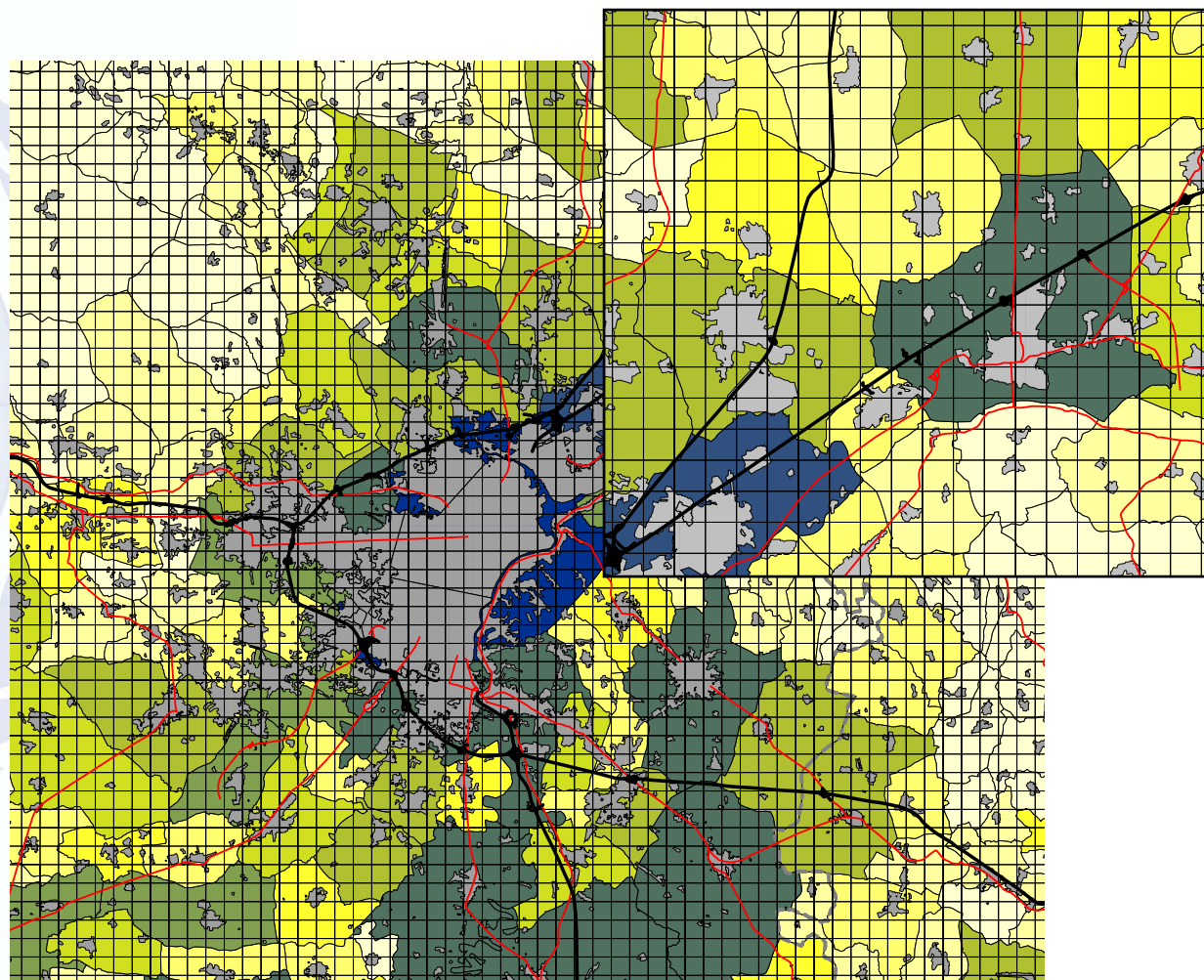
Area sources: grid allocation

- Polygons geometry
- Pollutants emission rates
- Allocation on the modelling grid

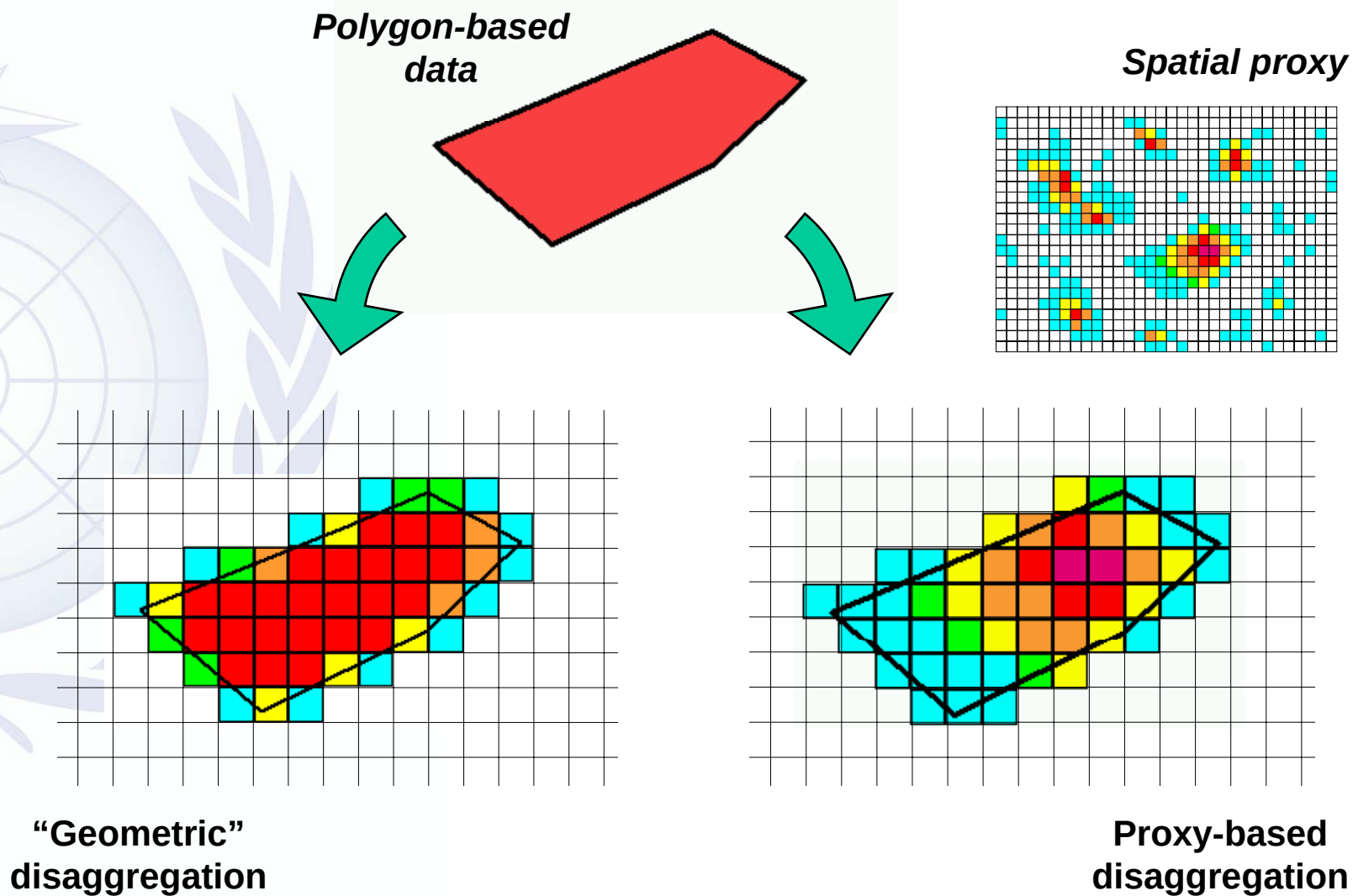
*Polygon-based
data*



Spatial characterization: related to scale



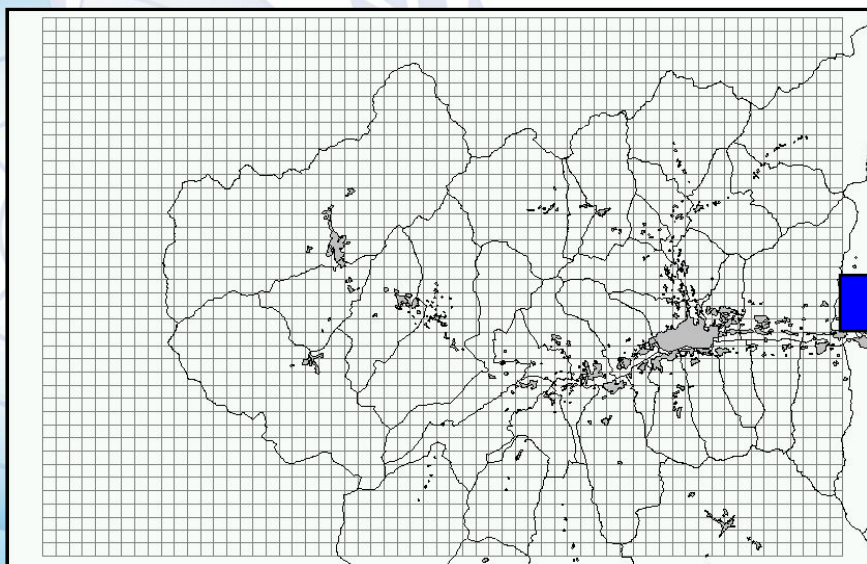
Area sources: grid allocation



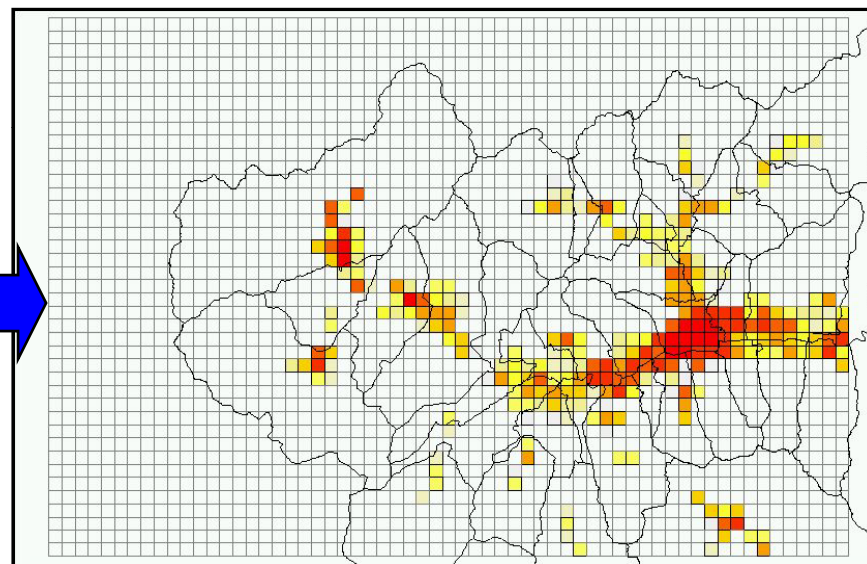
Proxy-based allocation ⁽¹⁾

Example: Espace Mont Blanc

Urban areas



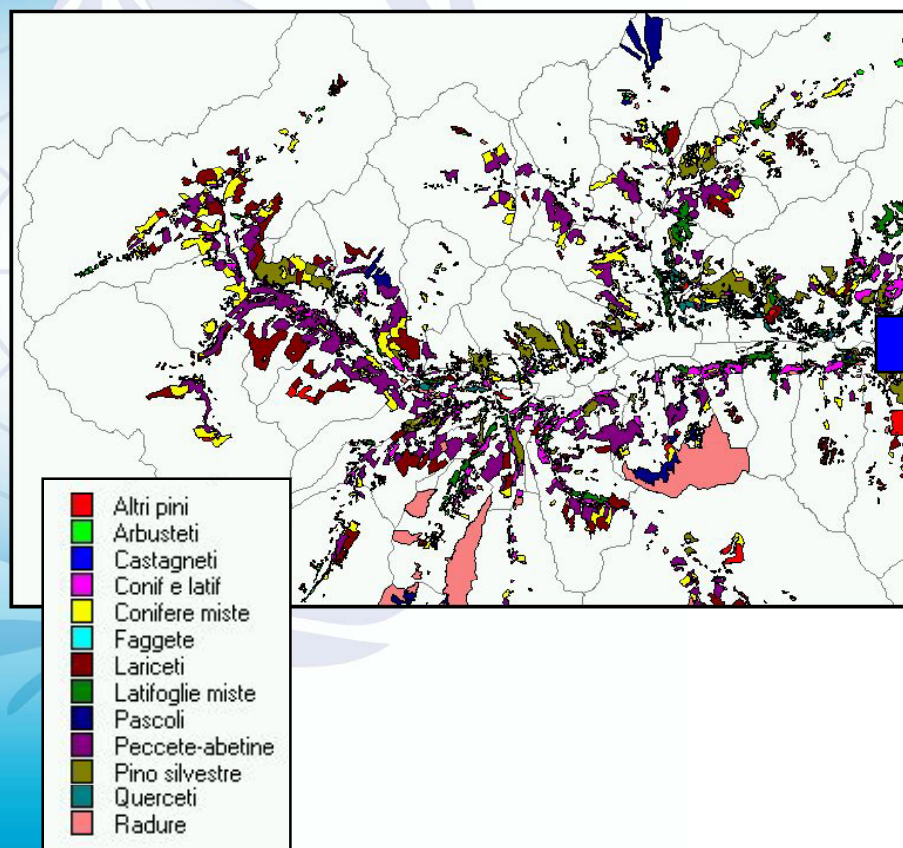
Emissions from heating



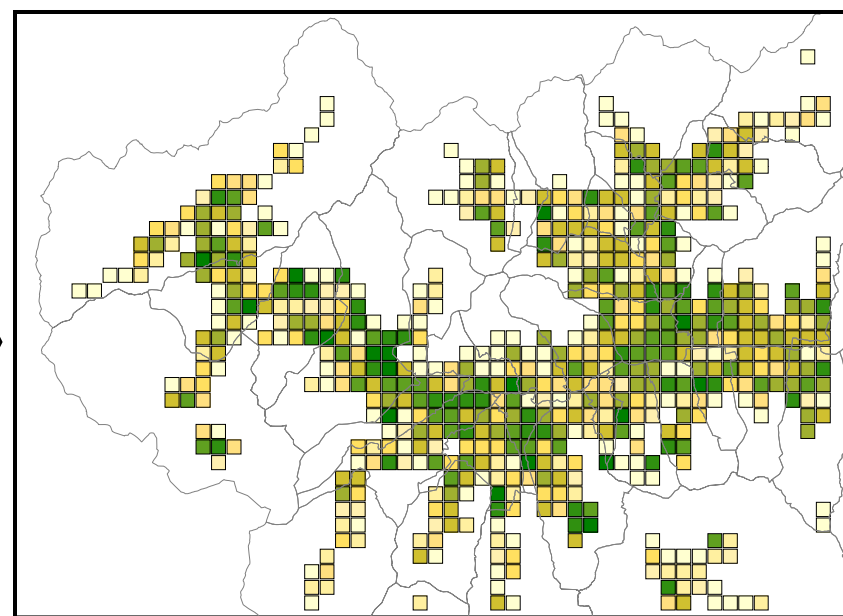
Proxy-based allocation (2)

Example: Espace Mont Blanc

Distribution of vegetation species

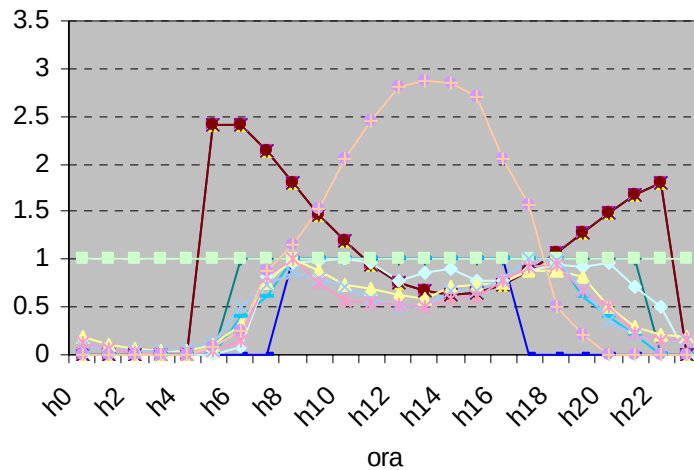


Biogenic NMVOC emissions

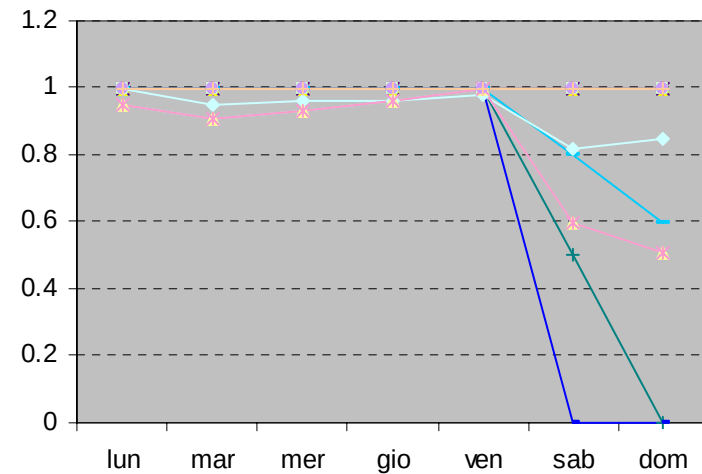


Time modulation (1)

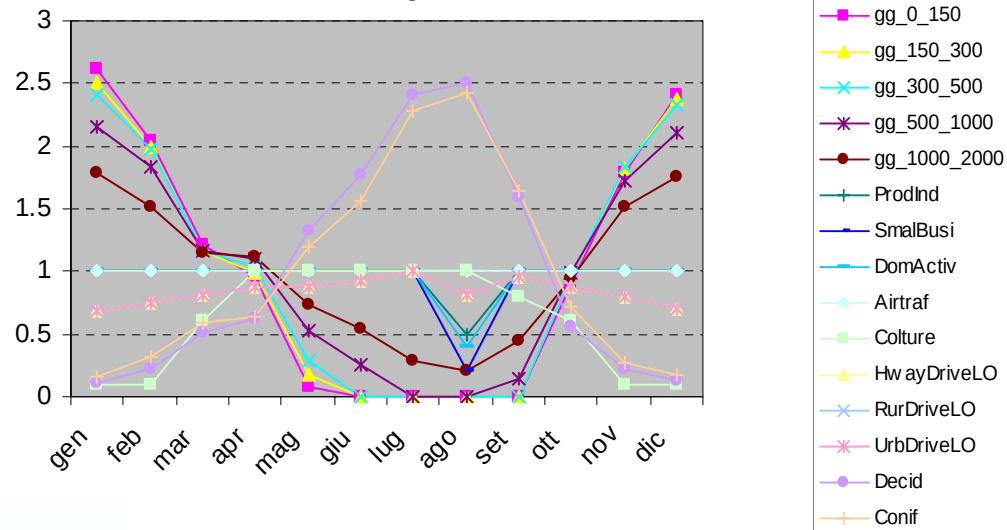
Daily



Weekly



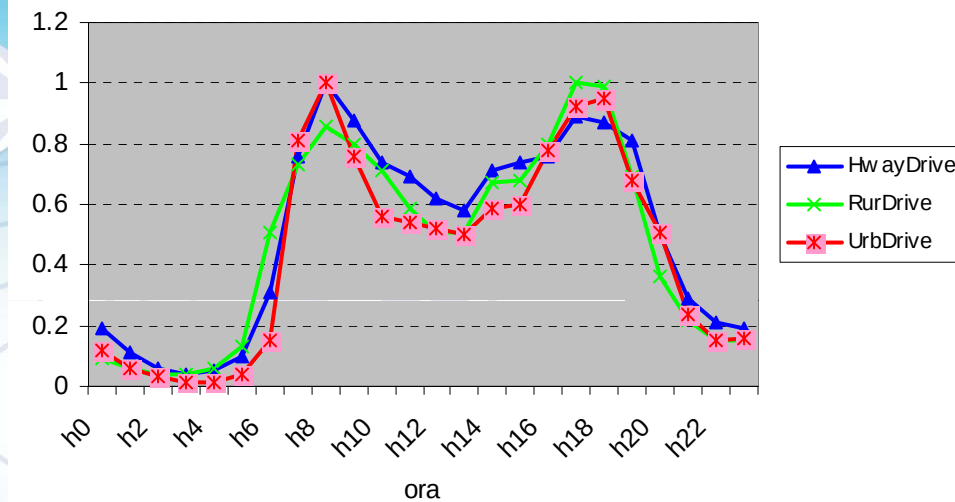
Yearly



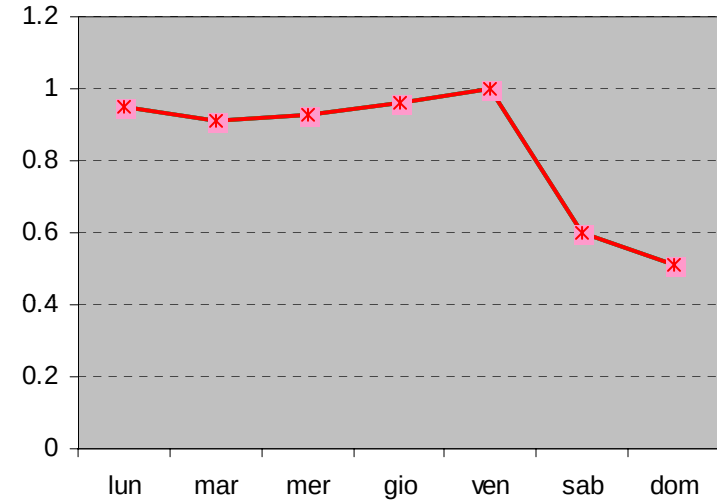
Time modulation (2)

Example: traffic

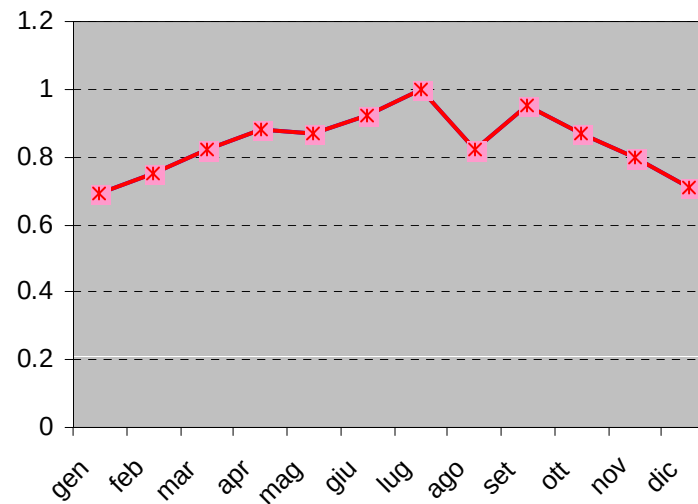
Daily



Weekly



Yearly



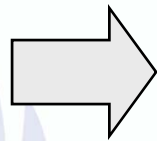
Chemical species

VOC

PM

NO_x

...



Speciated (lumped) hydrocarbons

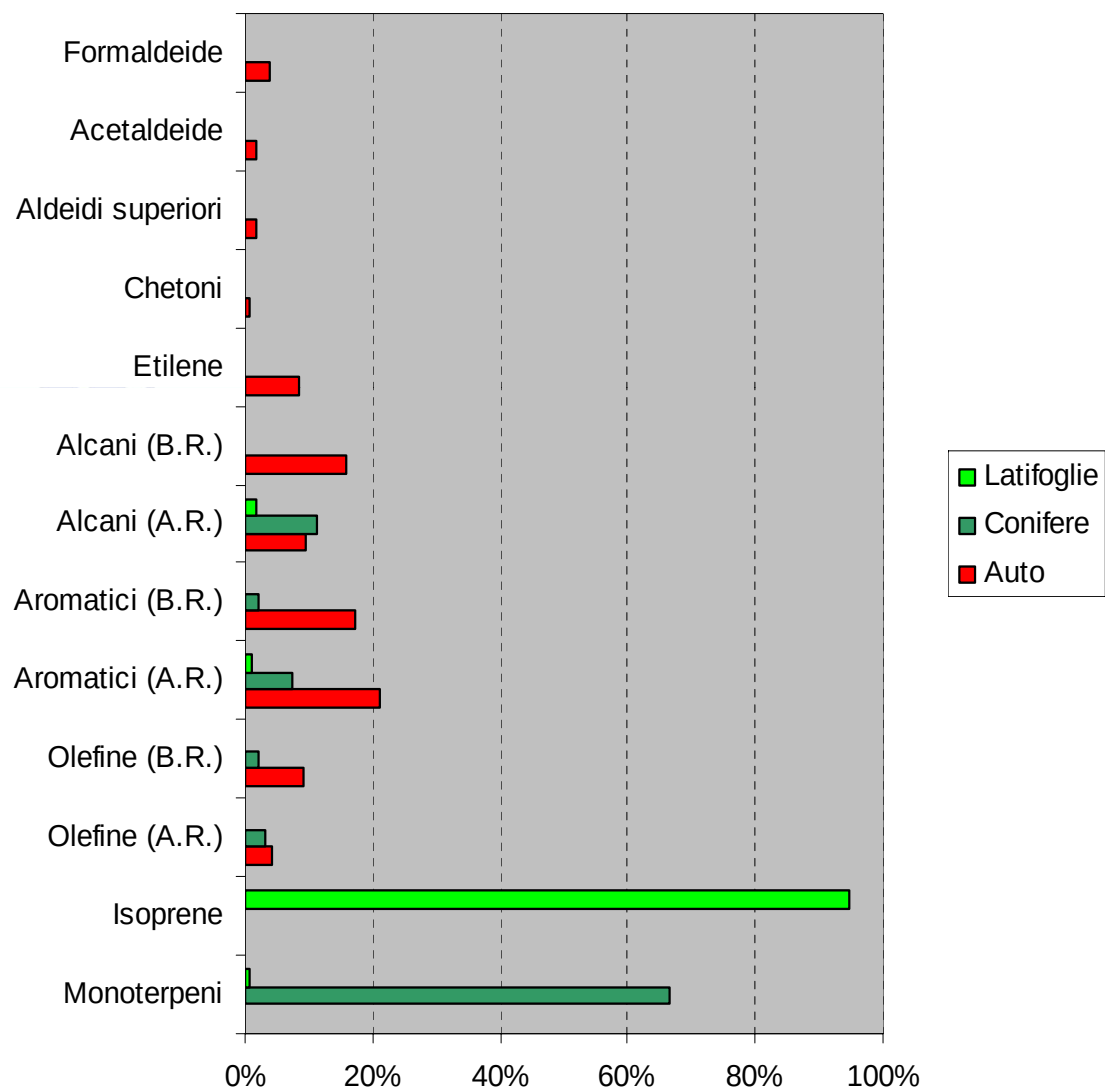
Size resolved (classes / bins)

NO & NO₂

...

...according to the needs of the AQM in use

NMVOC speciation profiles



Resources for speciation

US EPA

<http://www.epa.gov/ttn/chief/software/speciate/index.html>

CARB (California Air Resources Board)

<http://www.arb.ca.gov/ei/speciate/speciate.htm>

William P.L. Carter, U. of California, Riverside

<http://www.engr.ucr.edu/~carter/emitdb/>

NAEI (UKs National Atmospheric Emissions Inventory)

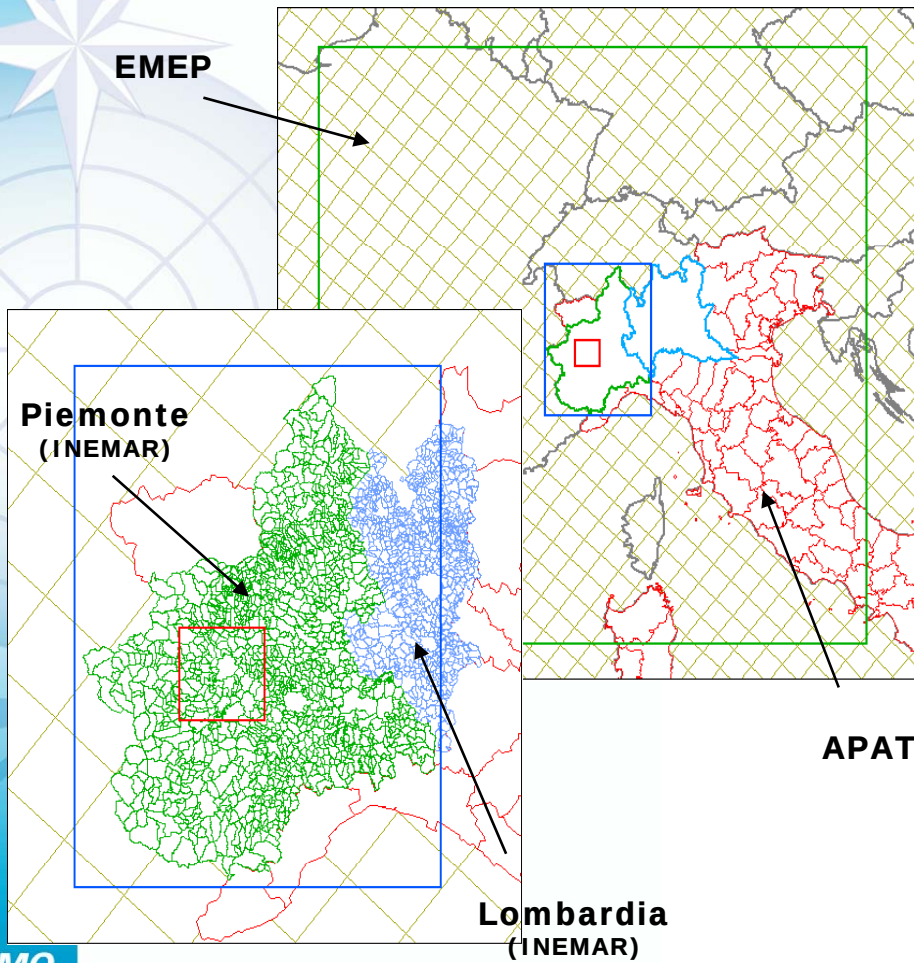
http://www.airquality.co.uk/archive/reports/empire/AEAT_ENV_0545_final_v2.pdf

EEA (European Environment Agency)

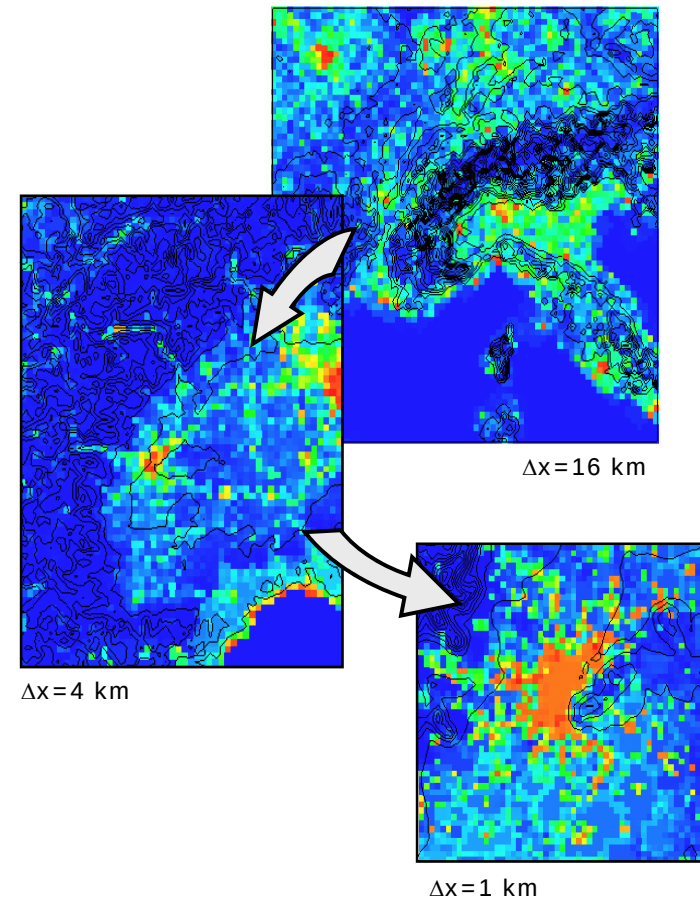
<http://reports.eea.europa.eu/EMEPCORINAIR5/en/page002.html>

Multiple emission inventories

Inventories



Consistent model input



Multiple emission inventories

Matching & consistency:

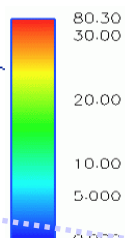
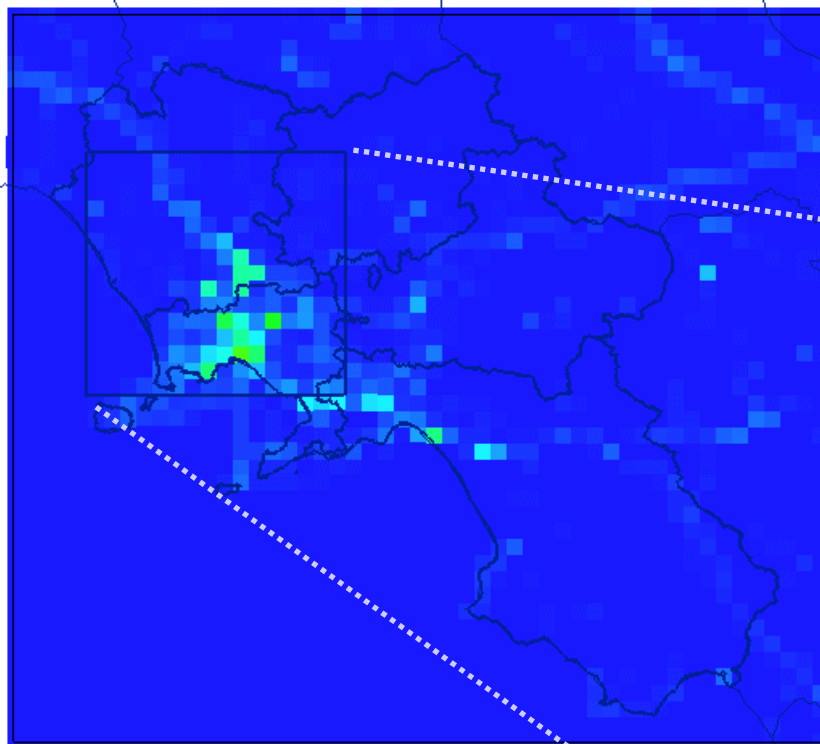
- geographic
- emissions
- Same scale / multiple scales
- Cross-check, exchange activities ...

Time-varying model-ready input

Example: Campania & Napoli (S Italy), NO daily cycle (15 Jan)

Regional domain (4 km res.)

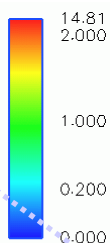
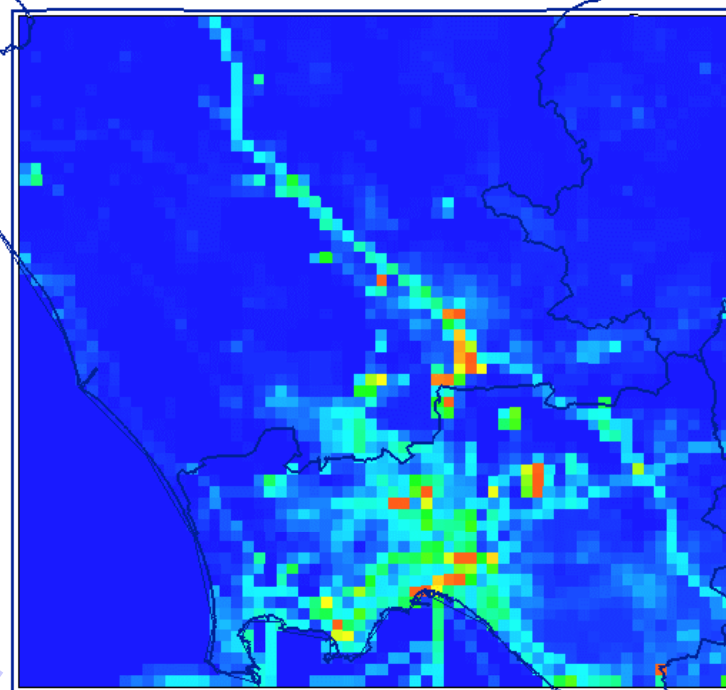
H 00:00:0.00



deNO
g/s/16 km2

Napoli & Caserta urban domain (1 km res.)

H 00:00:0.00



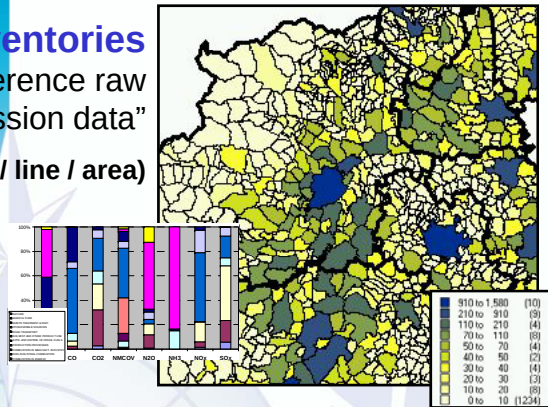
deNO
g/s/km2

Emissions processing for AQM

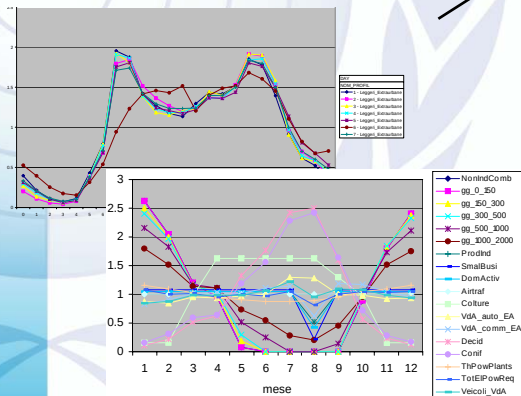
Inventories

“reference raw
emission data”

(point / line / area)



Modulation profiles (hourly, daily, monthly)



Model-ready input

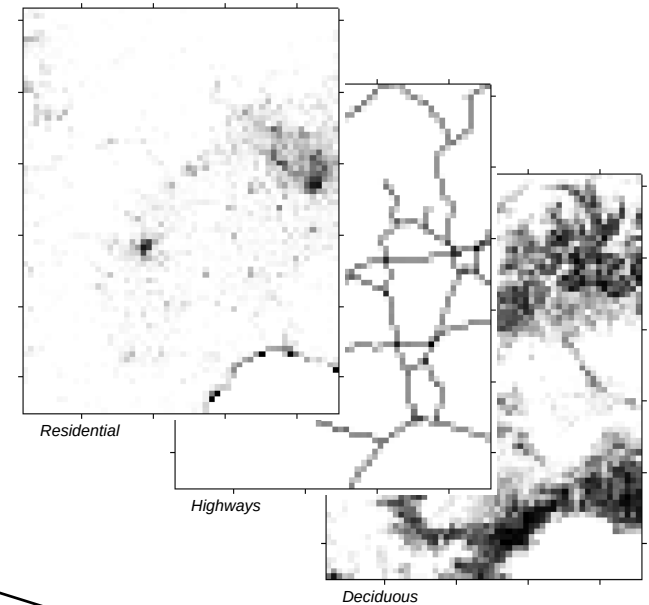
(hourly, gridded,
speciated emissions)

SPACE
DISAGGREGATION

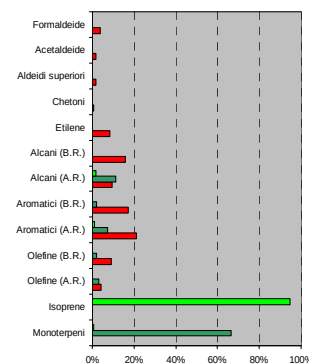
TIME
MODULATION

NMVOC & PM
SPECIATION & SIZE

Thematic data



Speciation & dimensional profiles



Other types of emission data

- Emissions estimated “on-line”, using current meteorology
 - desert dust
 - sea salt
 - forest fires
- Data from plants emissions monitoring systems
- Real-time traffic
- Accidental releases

Other factors

- Periodical update of inventory data
(changes in activity levels, fuels, control equipment ...)
 - Special situations
(traffic bans, events, ...)
 - Future scenarios
- ...examples later

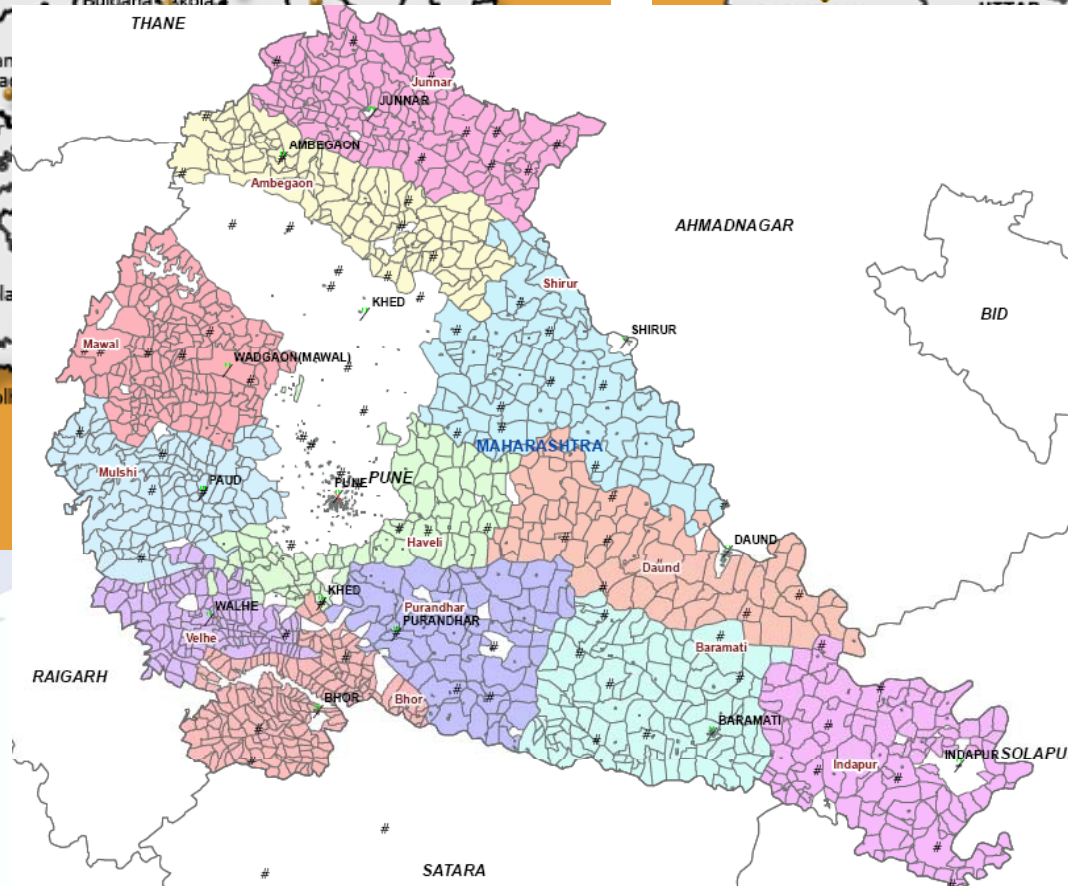
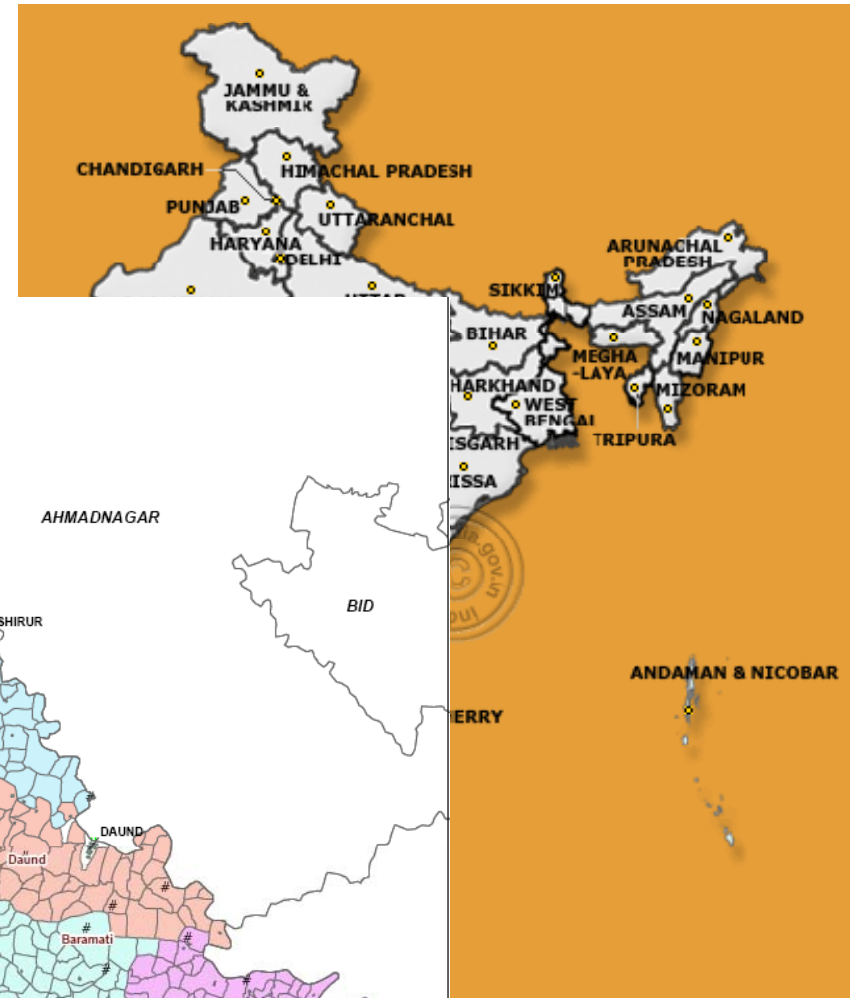
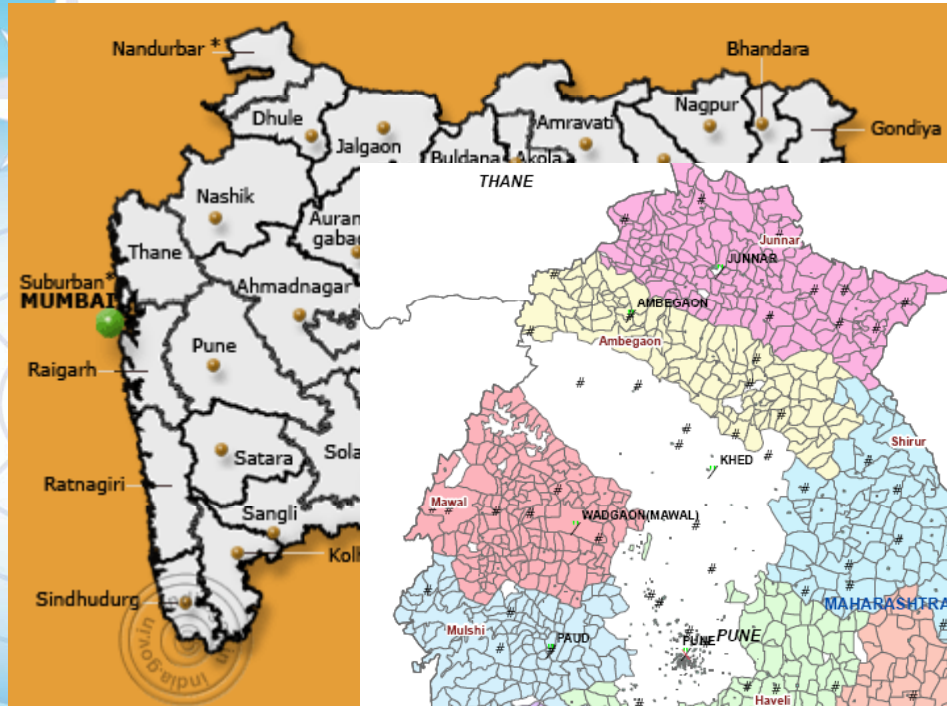
Emission input preparation

- Inventory data (point, line, area)
- Disaggregation:
 - grid allocation
 - time modulation
 - speciation
- Ancillary/proxy data
- Category- / source-based
- Localization (site- and source-specific data)
- Consistency
- Inventory vs. on-line data

AQM input data sets

- Meteorology
- Emissions
- Geographic data
- Chemical boundary conditions

Administrative boundaries



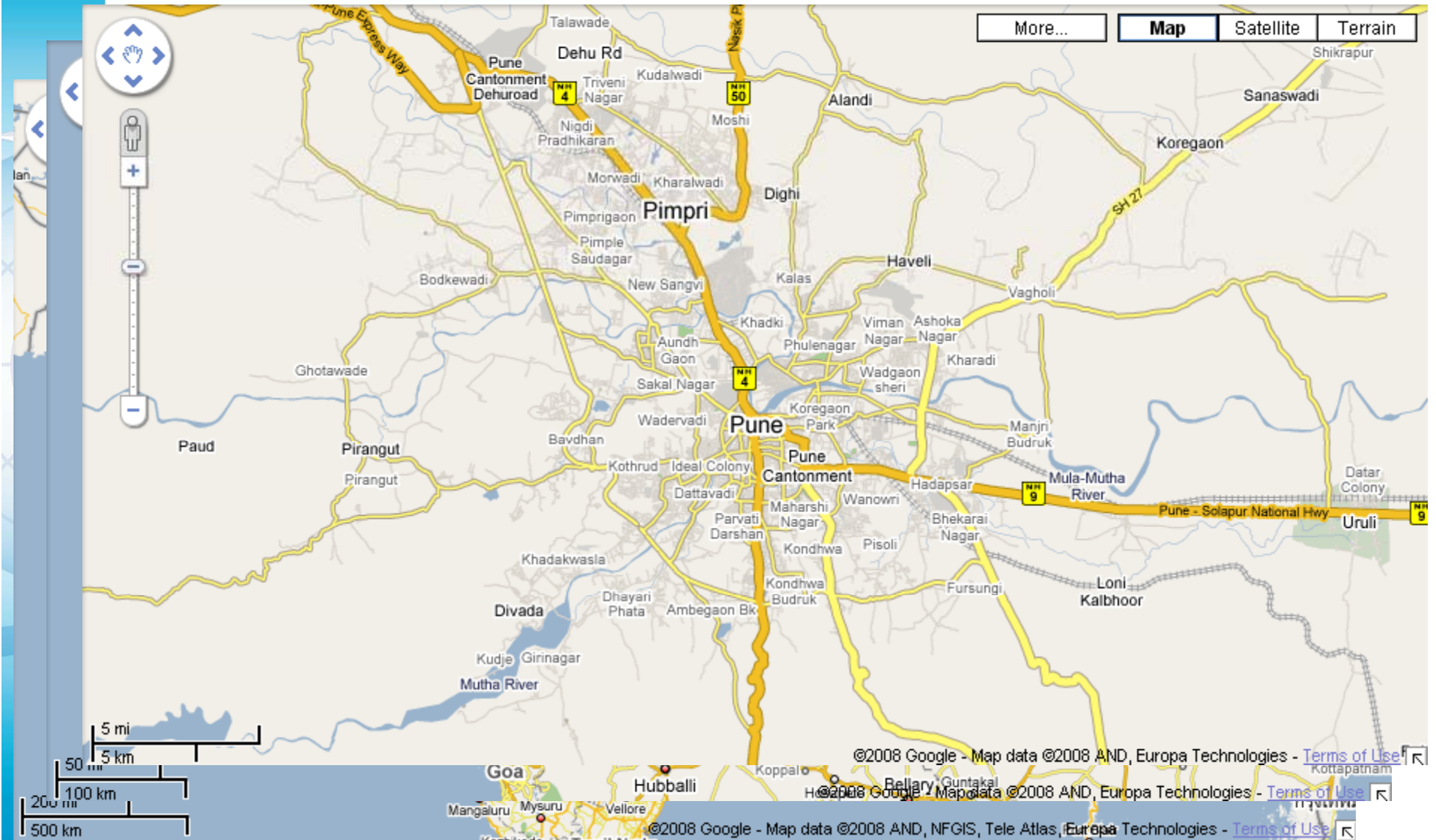
India National GIS Project
Source: Survey of India, 2005
Composed by: National Informatics Centre

Administrative units



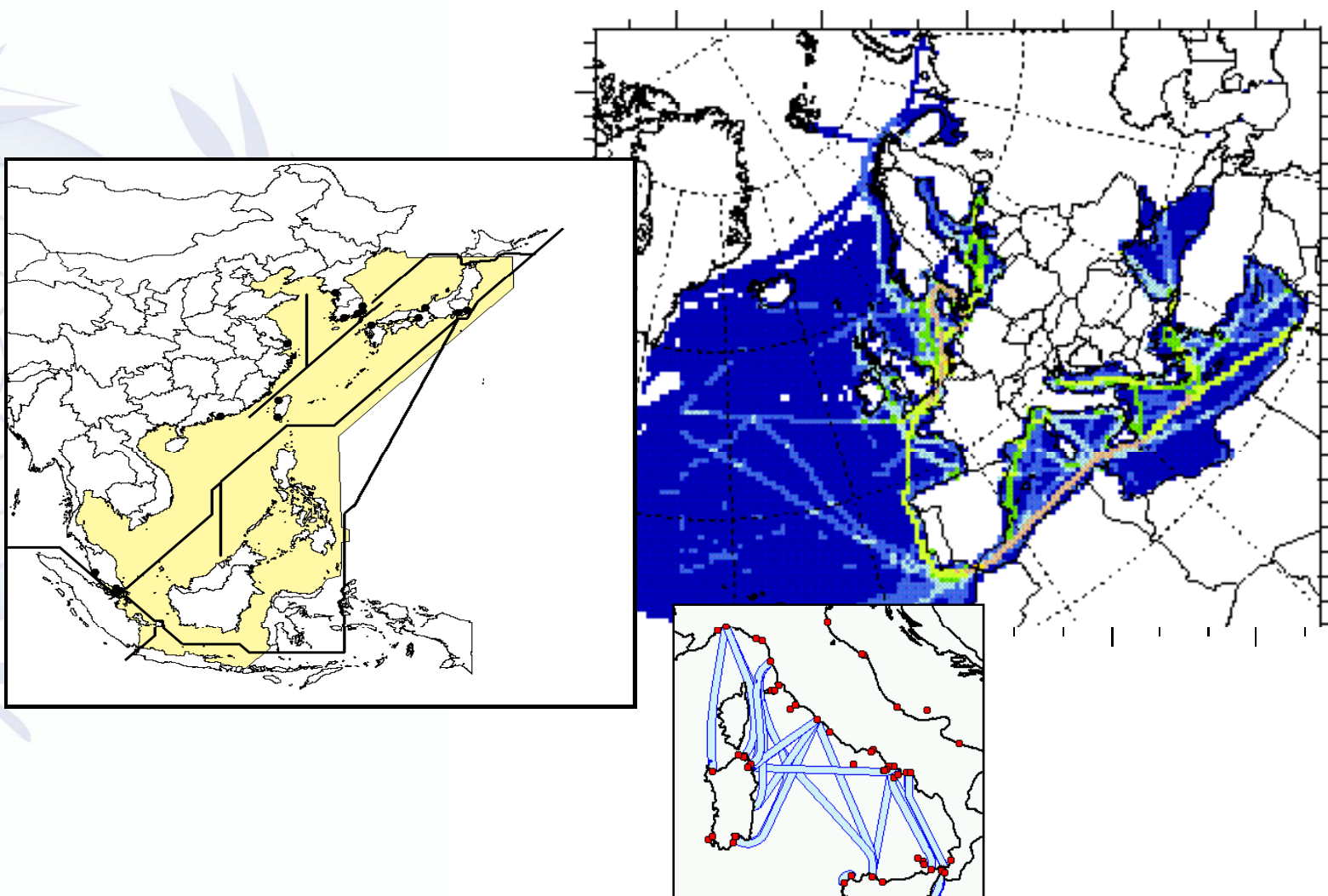
Transportation networks (1)

Roads



Transportation networks (2)

Sea lanes

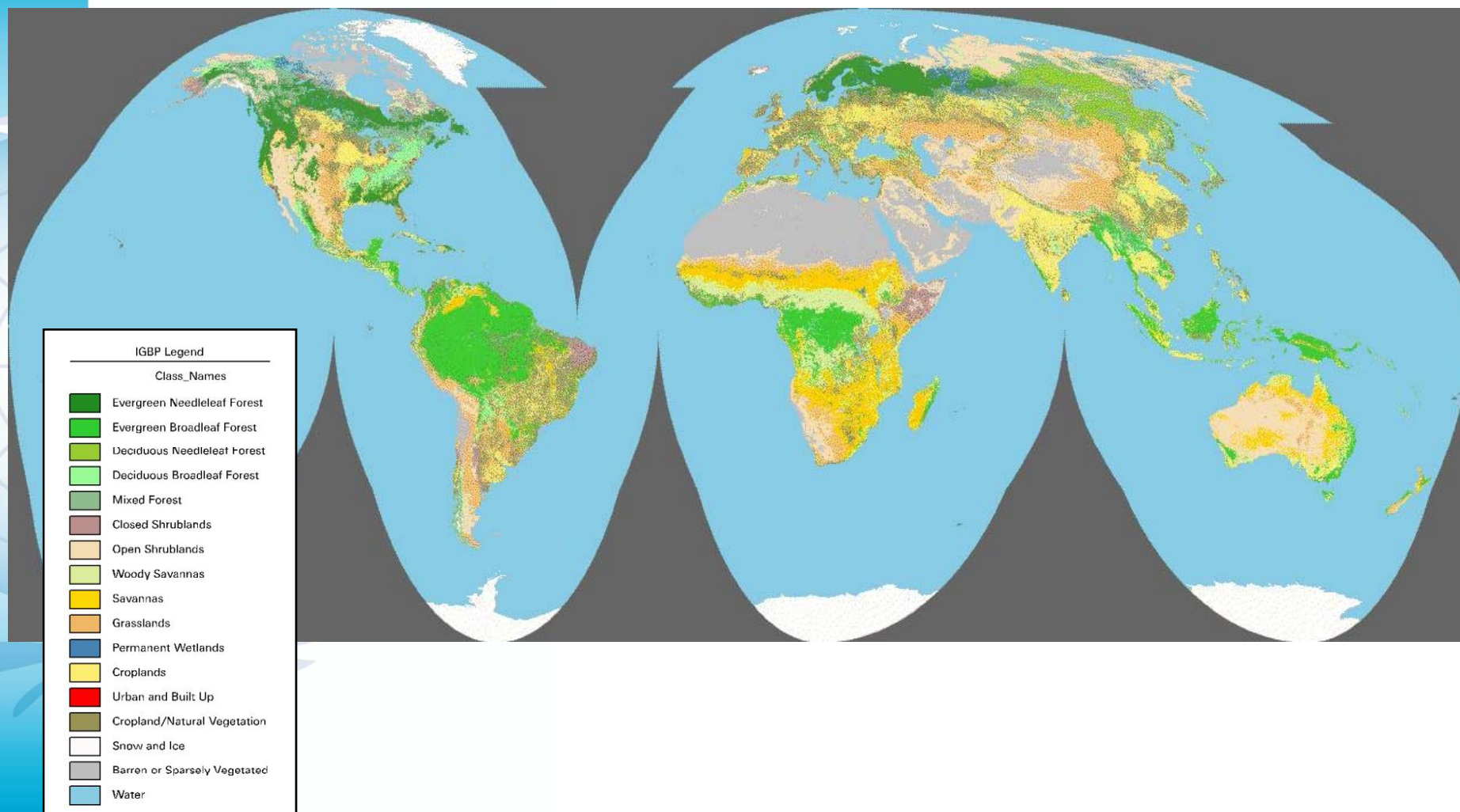


Vector geographic data

- Describe sources geometry
- Reference cartography
- Digitalization
- GIS (Geographic Information Systems)

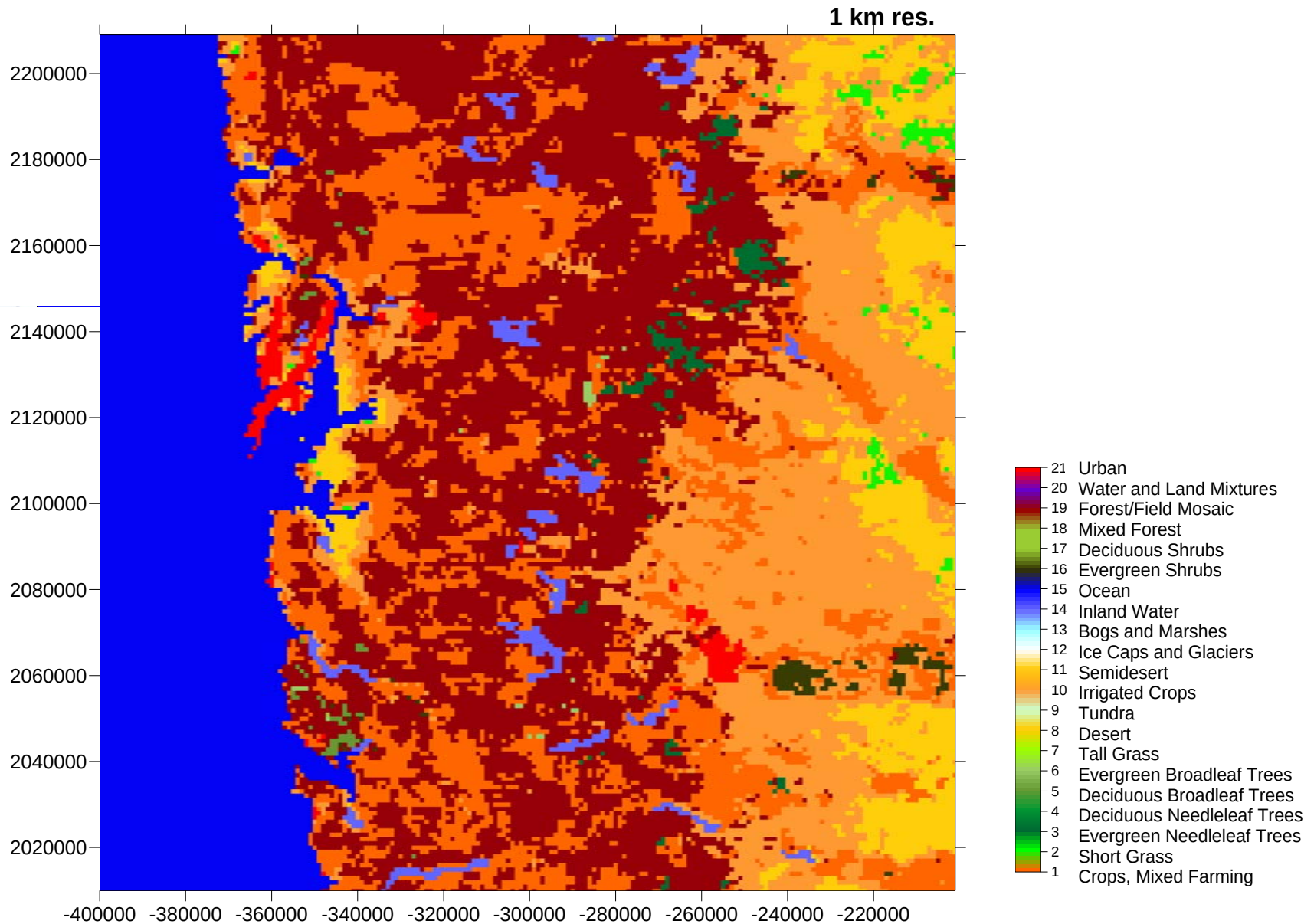
Raster data

Example: USGS Global Land Cover



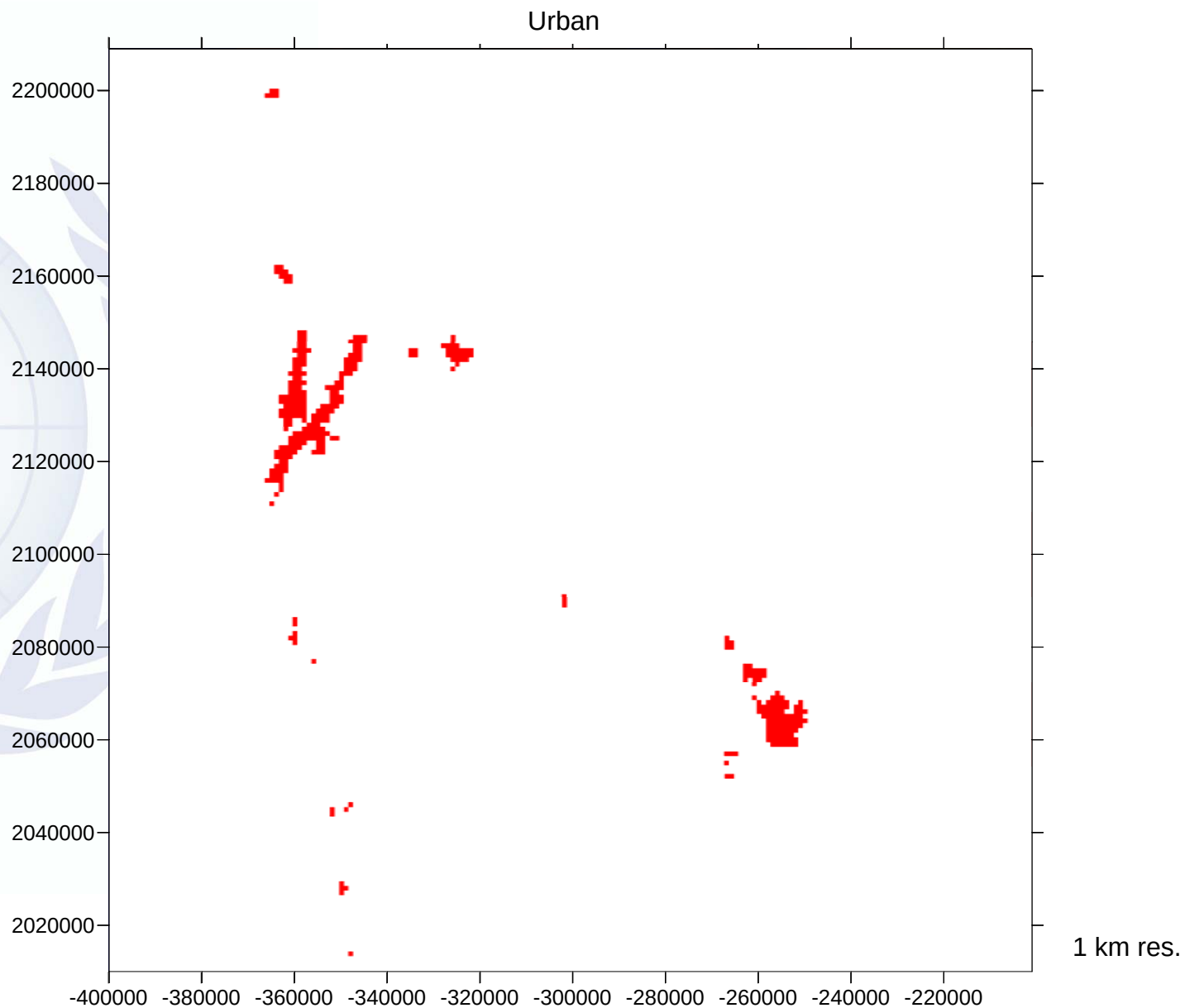
Land cover data extraction/regridding

Example from USGS Global Land Cover



Extraction of classes

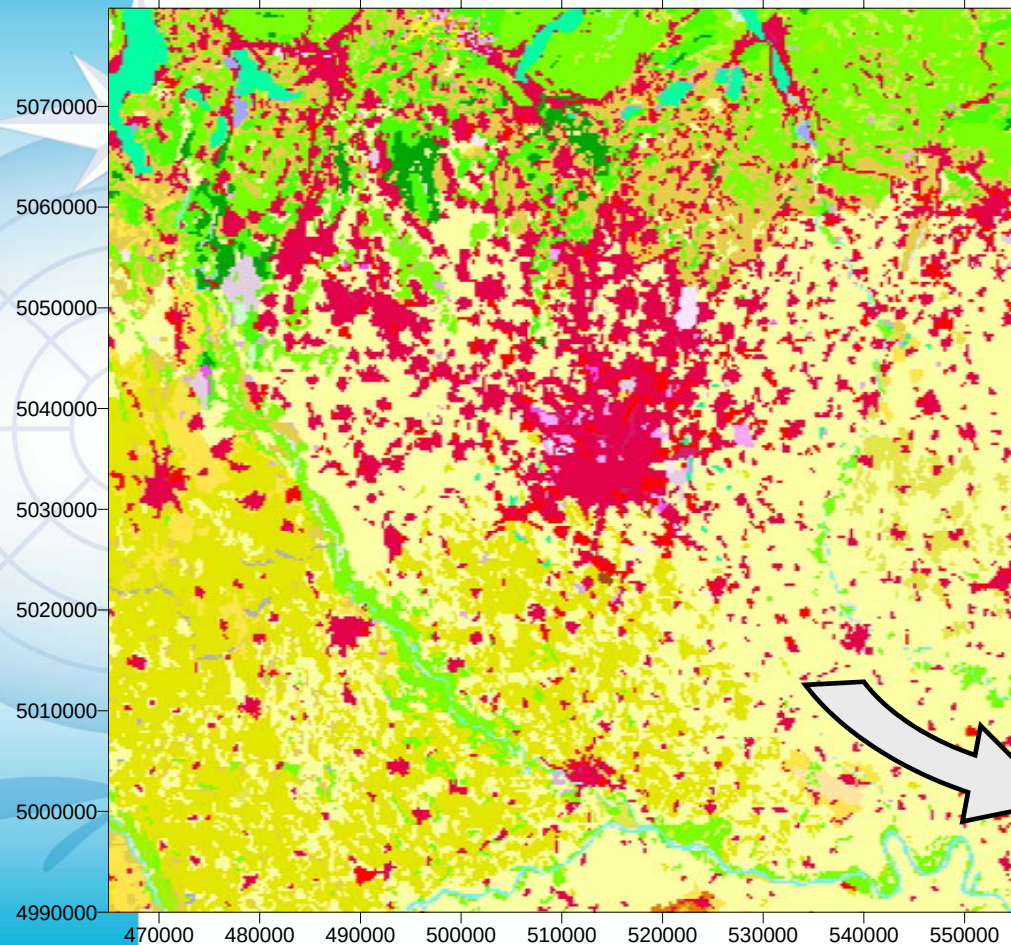
Example from USGS Global Land Cover



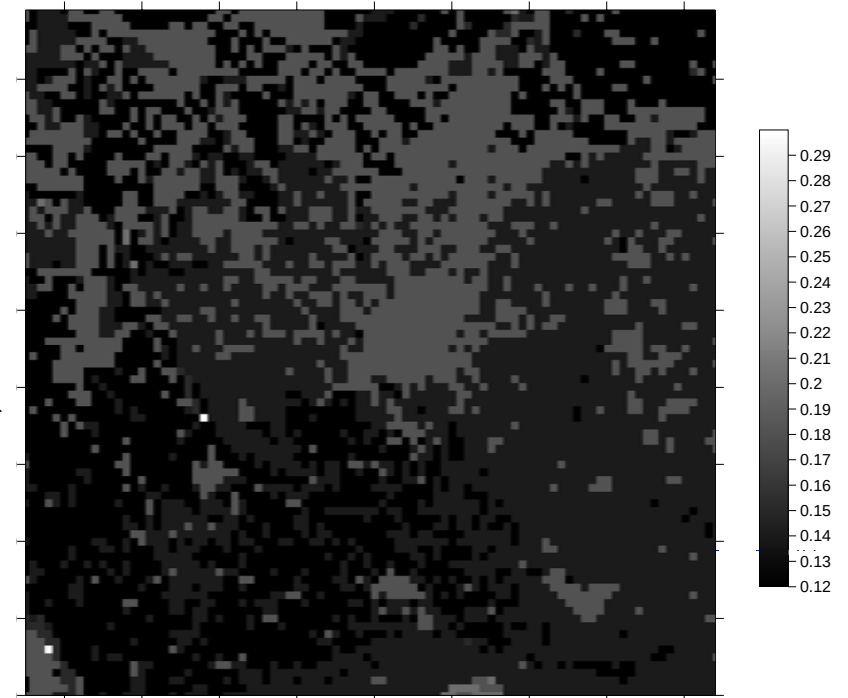
Assignment of parameters for meteorological modelling

Example from EEA CORINE Land Cover

Land cover, 250 m res.



Albedo, 1 km res.

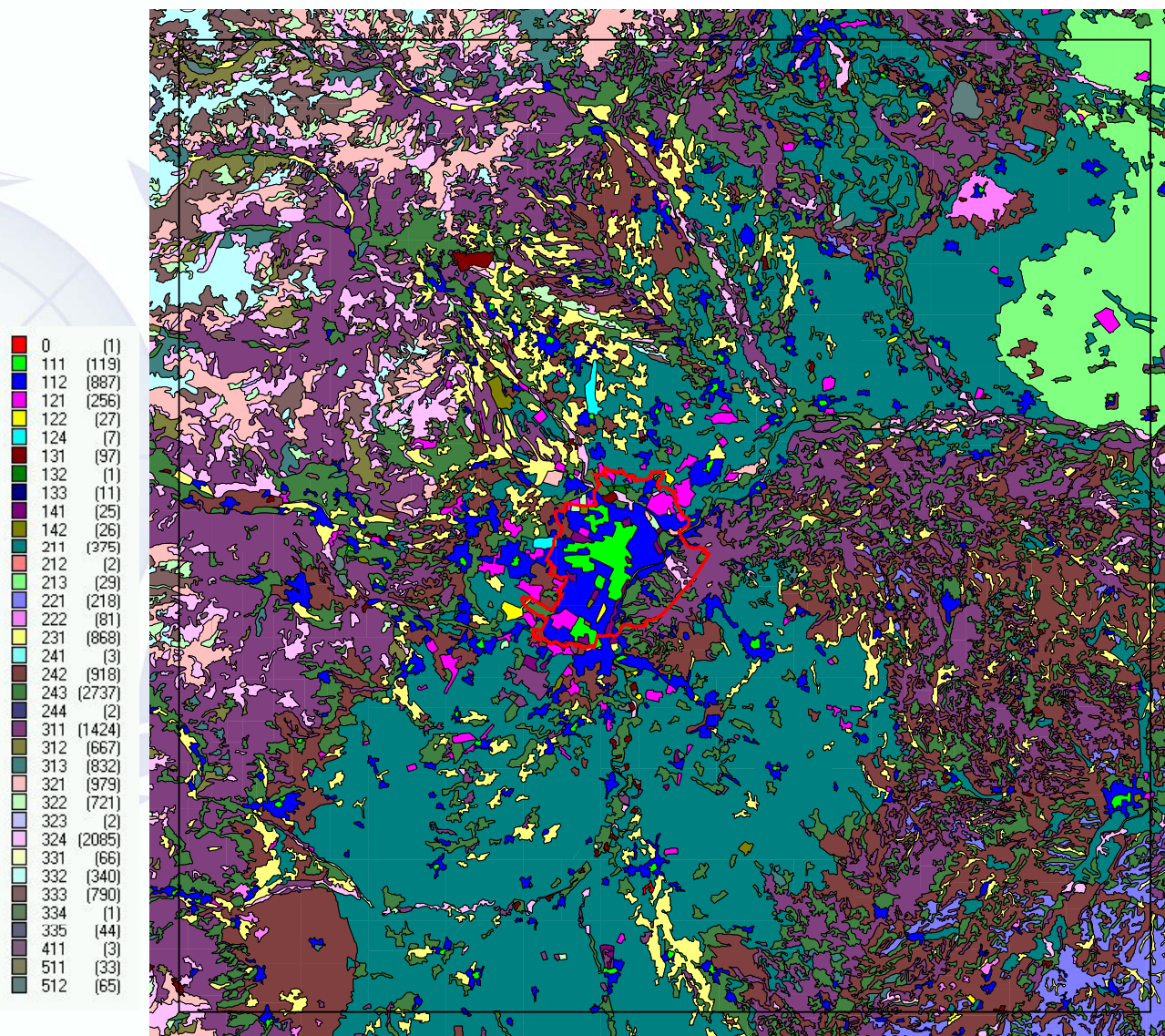


Raster land cover data

- Operations:
 - projection
 - re-gridding & statistics
 - re-classification
 - physical variables

Vector data

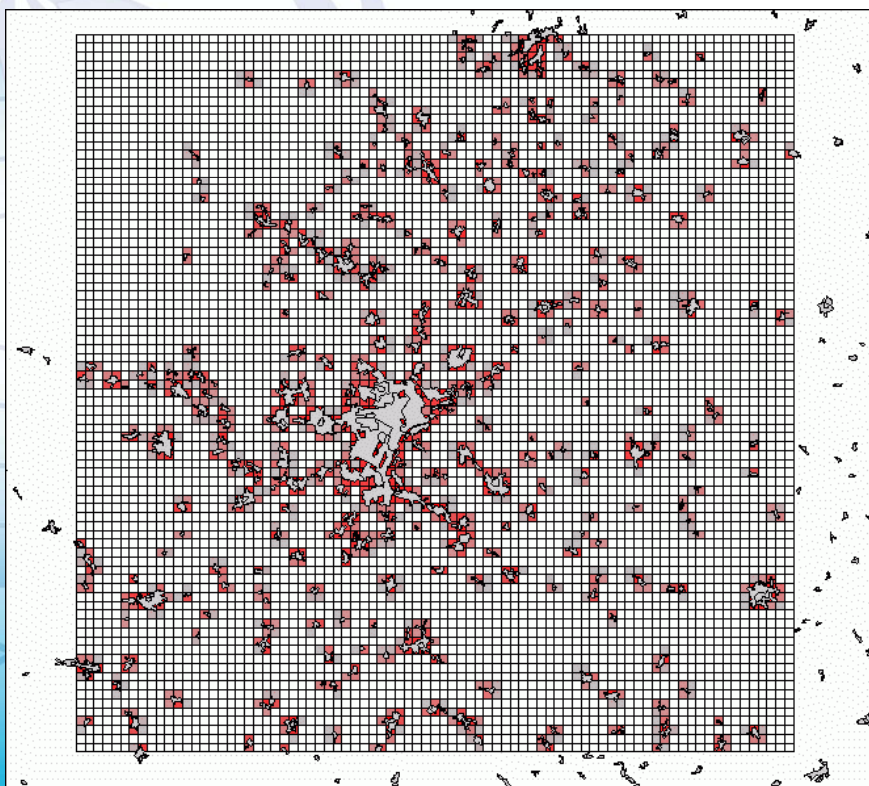
Example: EEA CORINE Land Cover



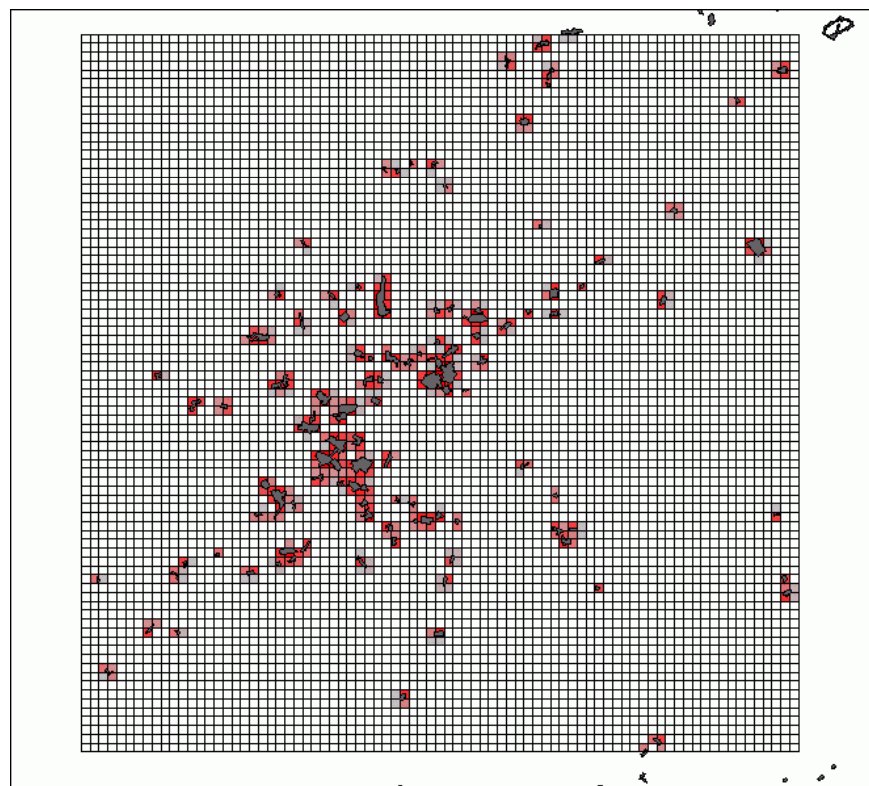
Extraction of gridded proxies

Example from EEA CORINE Land Cover (1)

Urban fabric



Industrial, commercial & transport units

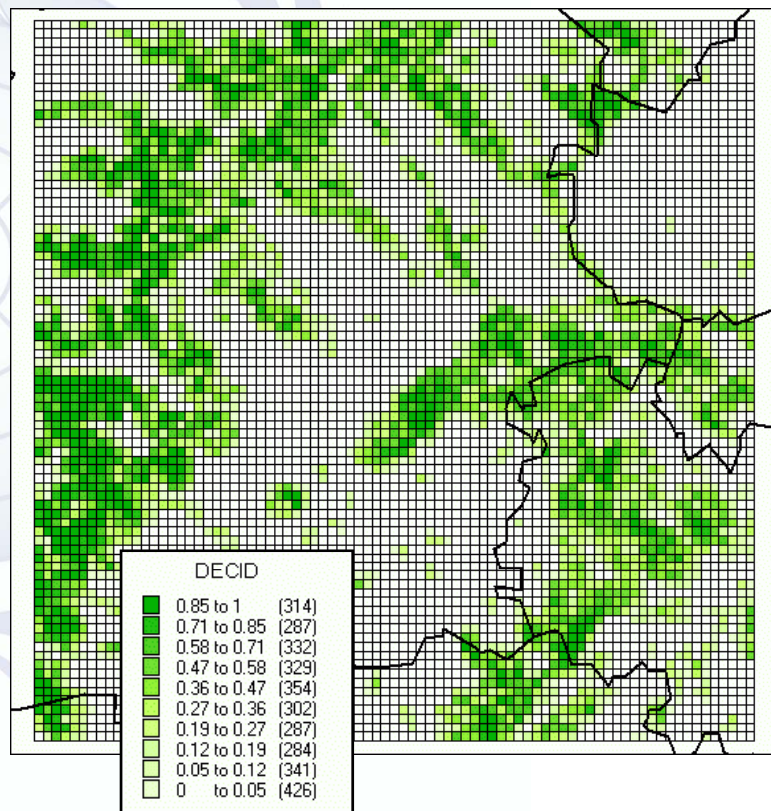


80x80 km domain – 1 km res.

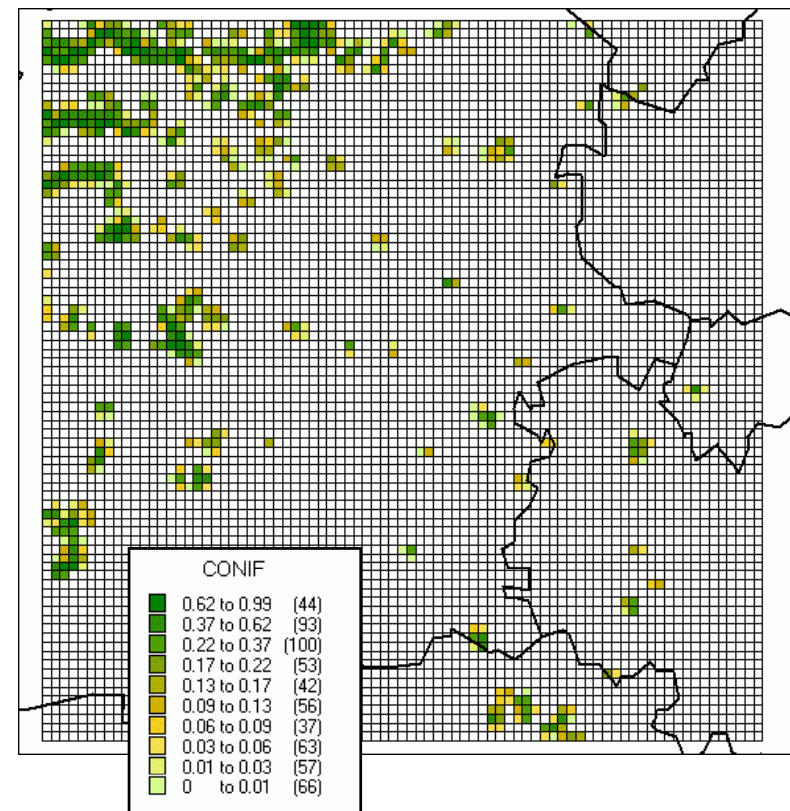
Extraction of gridded proxies

Example from EEA CORINE Land Cover (2)

“Deciduous forest”



“Coniferous forest”

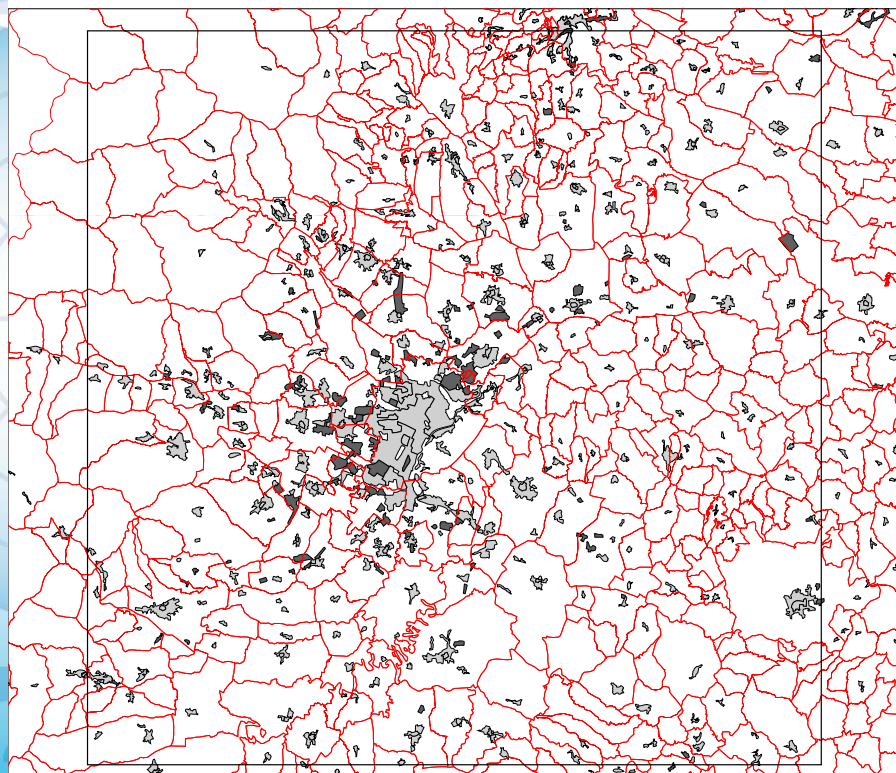


80x80 km domain – 1 km res.

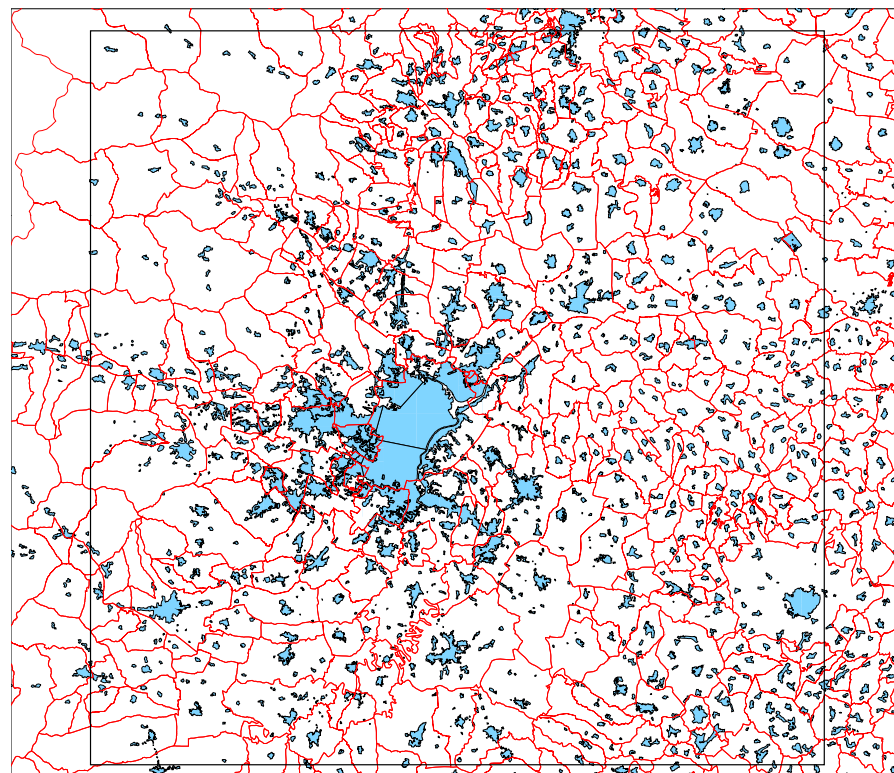
Detail: a matter of scale (1)

Example: builtup areas

CORINE Land Cover



IGM 1:100,000 + LANDSAT

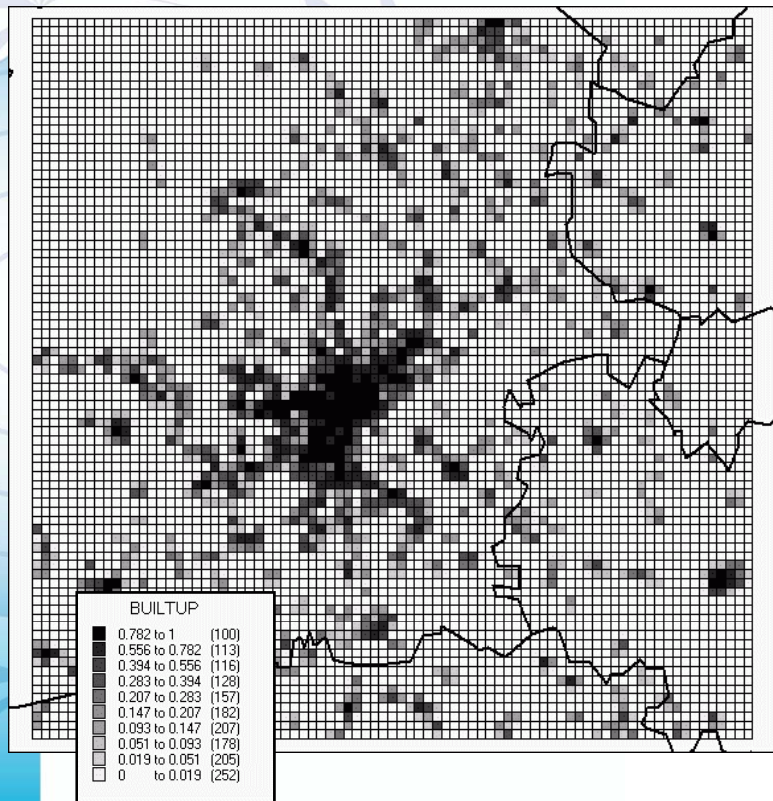


-  1.1 - Urban fabric
-  1.2 - Industrial, commercial and transport units

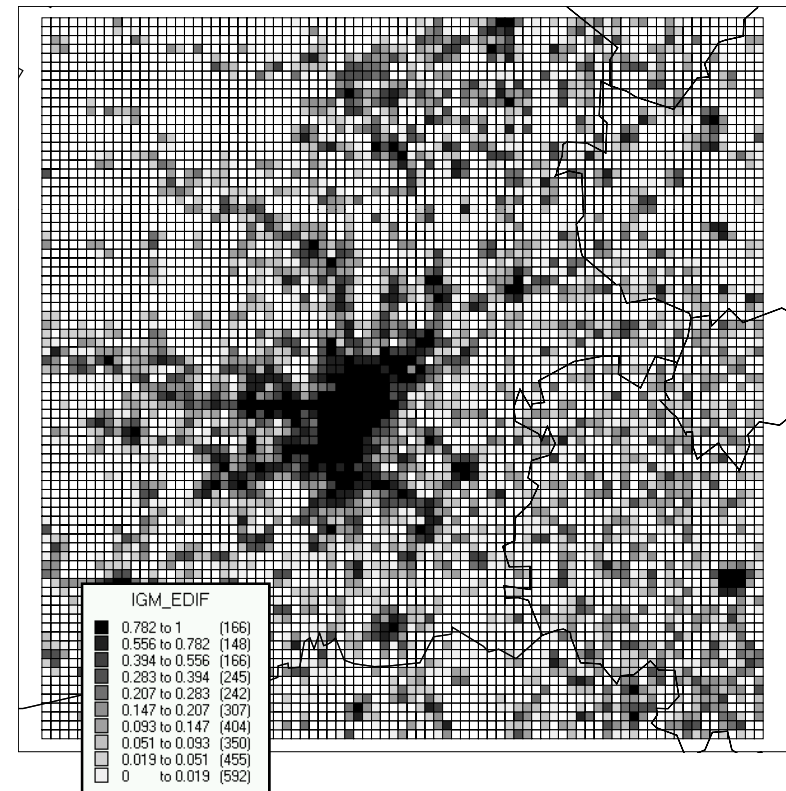
Detail: a matter of scale (2)

Builtup areas @ 1 km res.

CORINE Land Cover

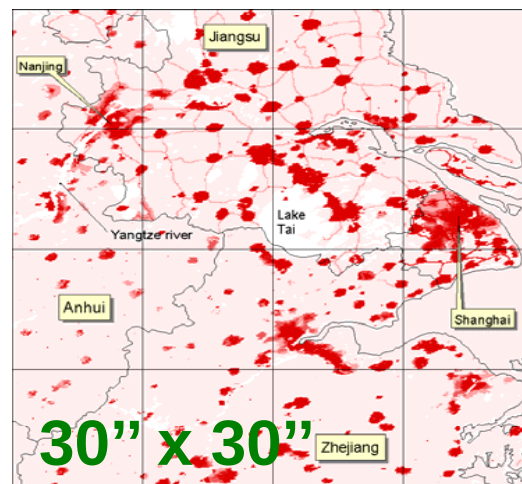
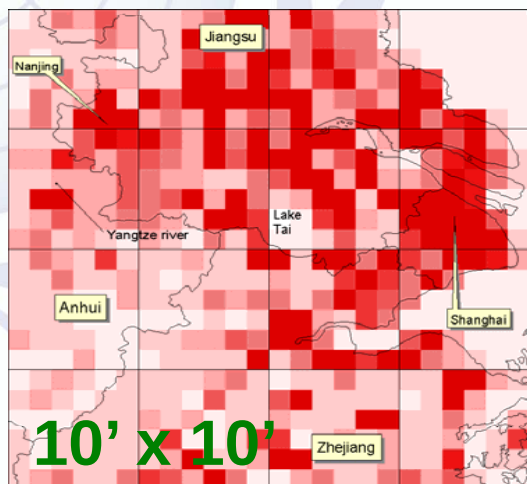
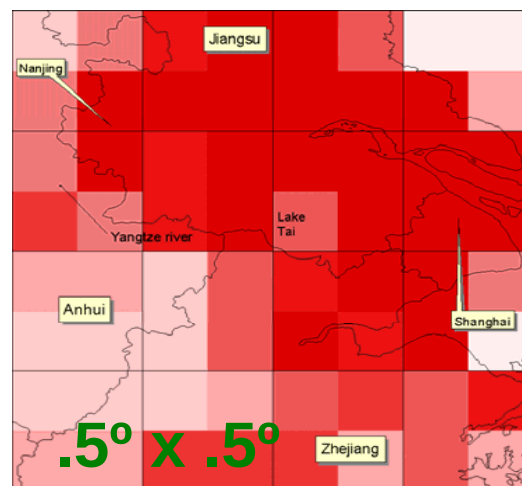
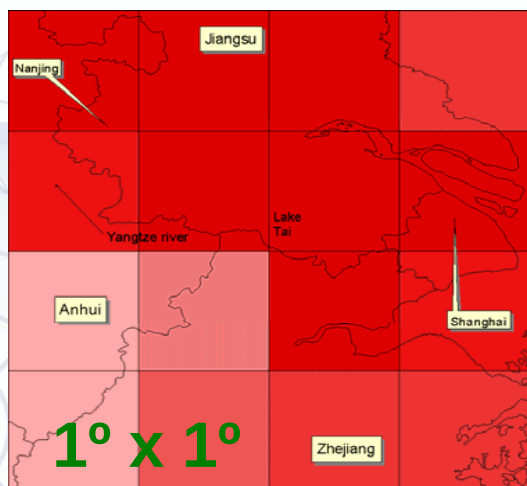


IGM 1:100,000 + LANDSAT



Detail: a matter of scale (3)

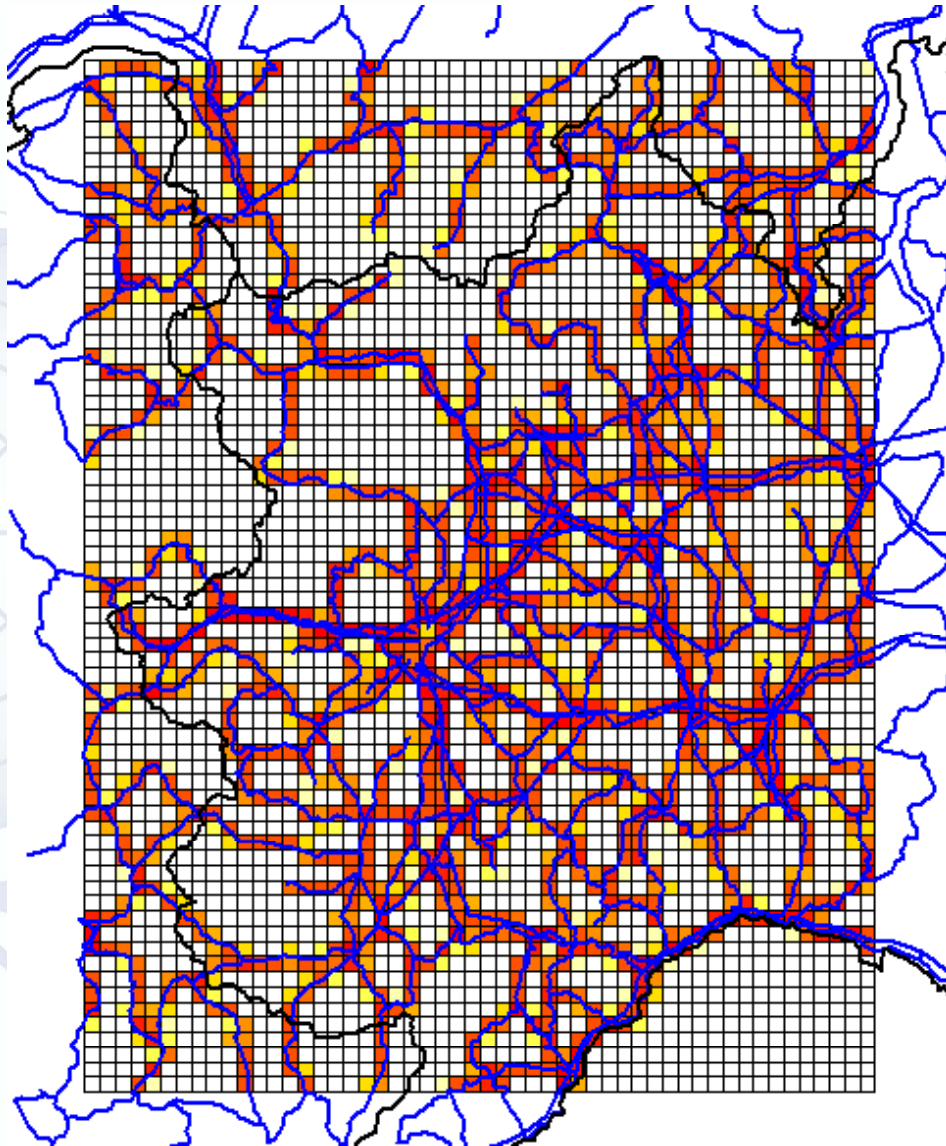
SO₂ emissions in the vicinity of Shanghai, China



Spatial proxies data

- Geographic detail $\Leftrightarrow$ model resolution
- Global / local data
- Area coverage of class feature
- Density maps (e.g. population)

Gridded proxy from transportation networks



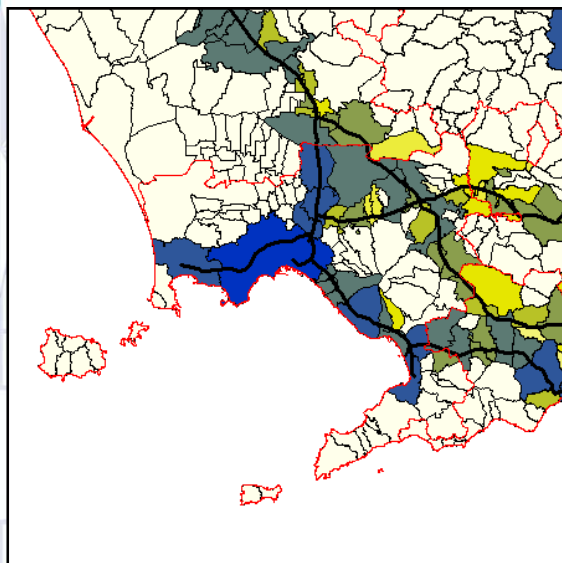
Example: major
roads - Piemonte

- Length
- Weighting (e.g. road type)

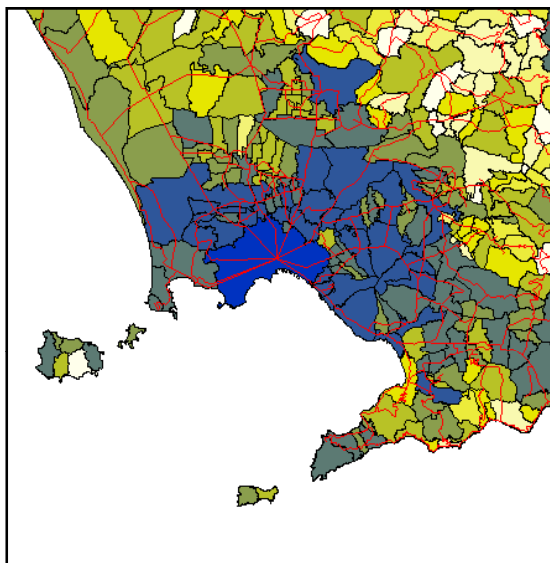
Gridded proxy from transportation networks

Example: road traffic (passenger cars, NO_x)

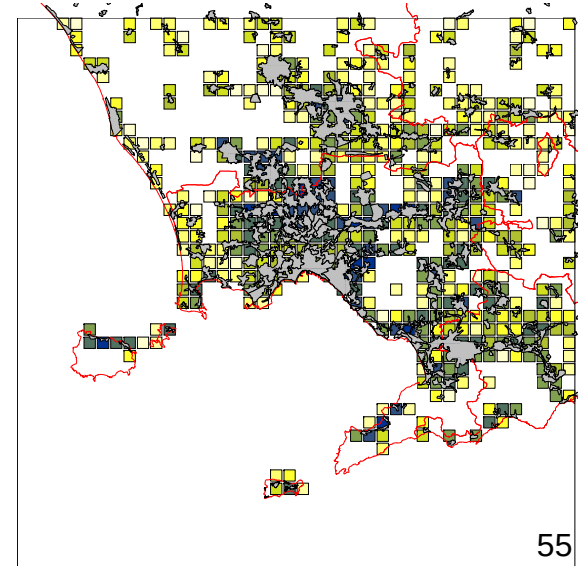
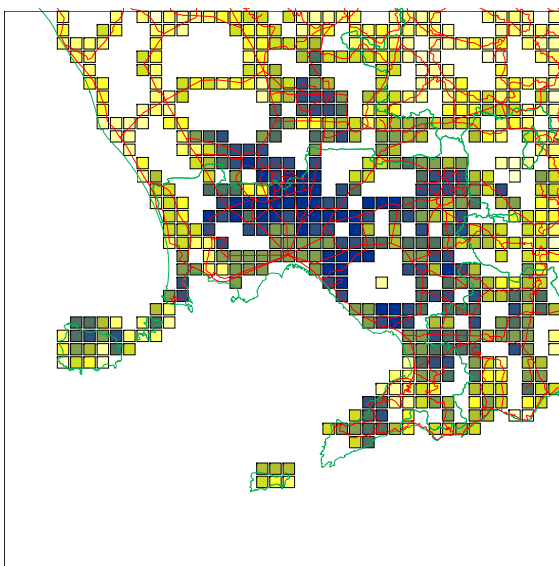
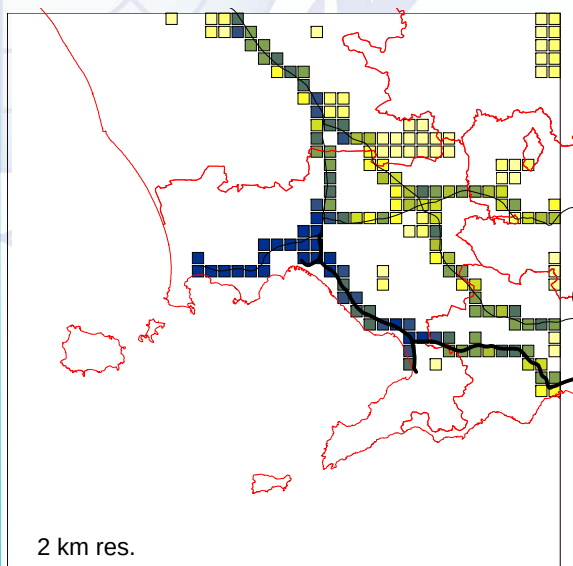
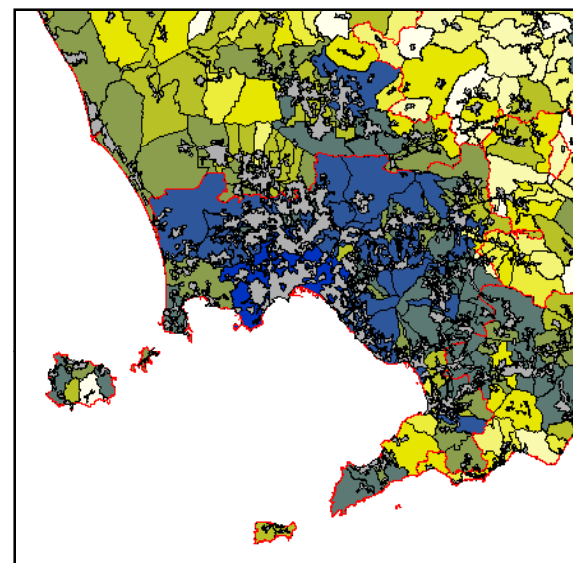
Highway



Rural



Urban



Geographic data

- Sources geometry
 - administrative boundaries
 - transportation networks
- Spatial proxies
 - land cover
 - raster
 - vector
 - transportation networks
- Global / local data sources
- GIS support

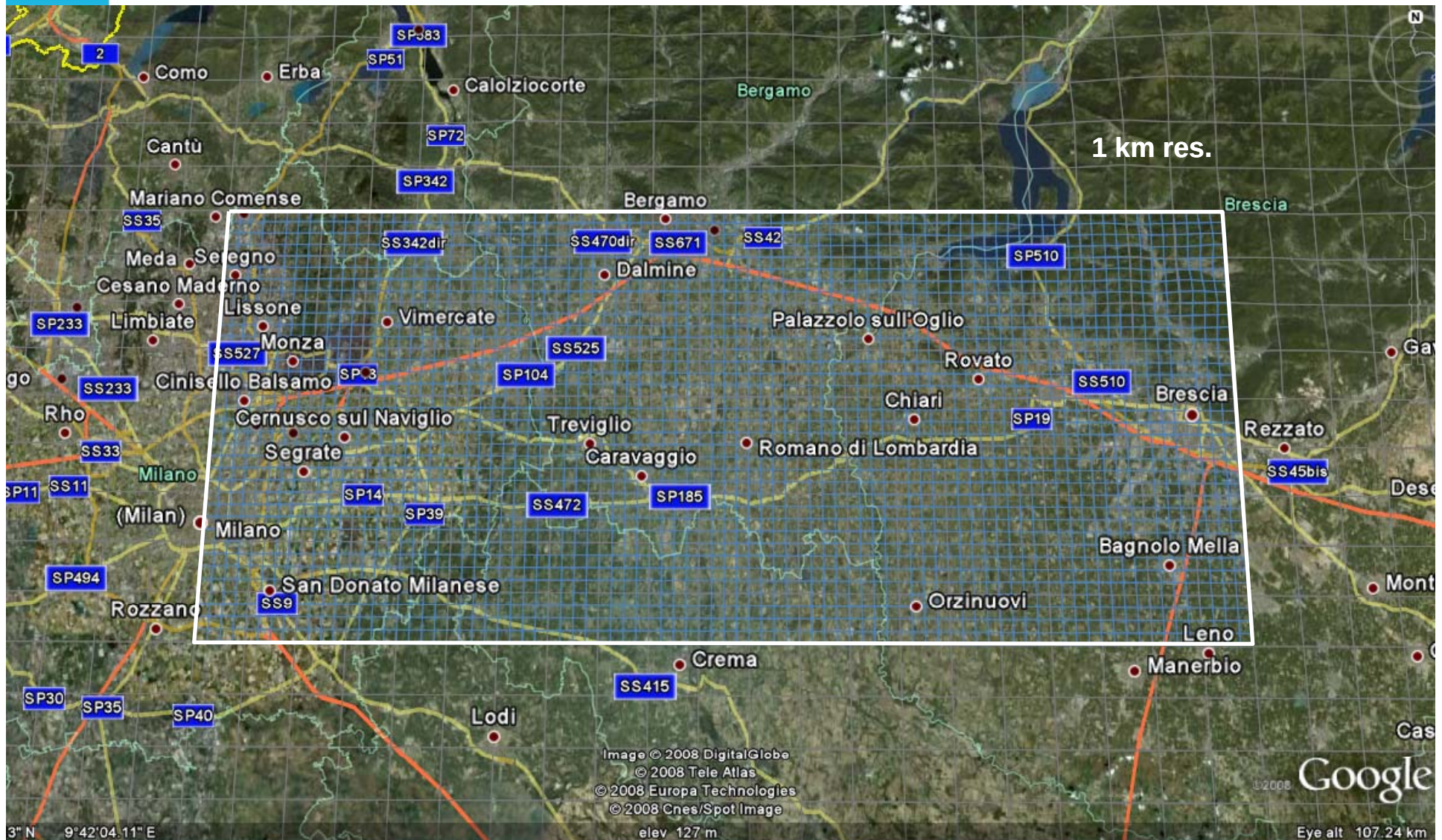
- ✓ emissions processing
- ✓ meteorological modelling

AQM input data sets

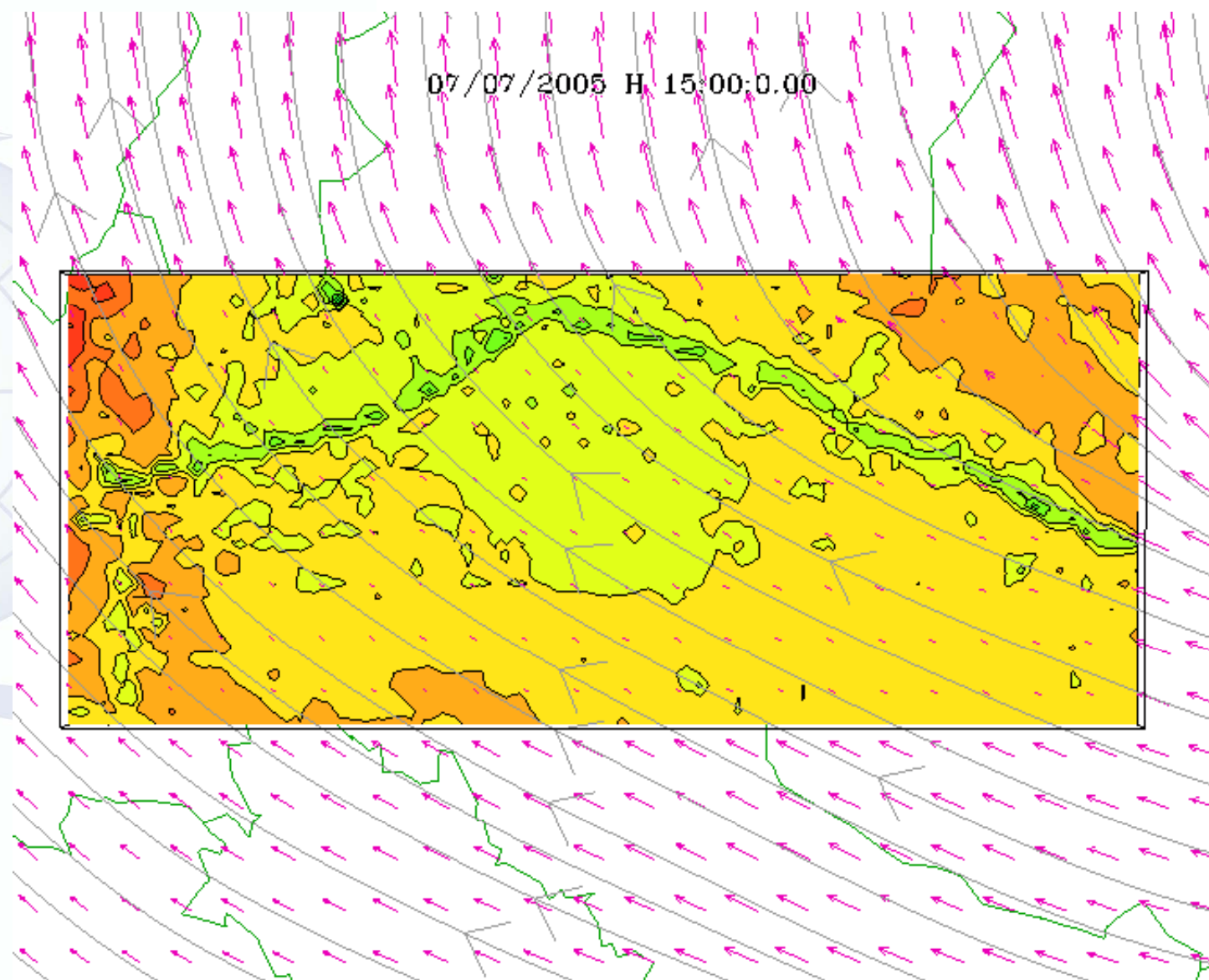
- Meteorology
- Emissions
- Geographic data
- Chemical boundary conditions

Broader context for AQM: chemical BC

Example: simulation domain on Lombardia, N Italy



Ground O₃ conc. on local domain

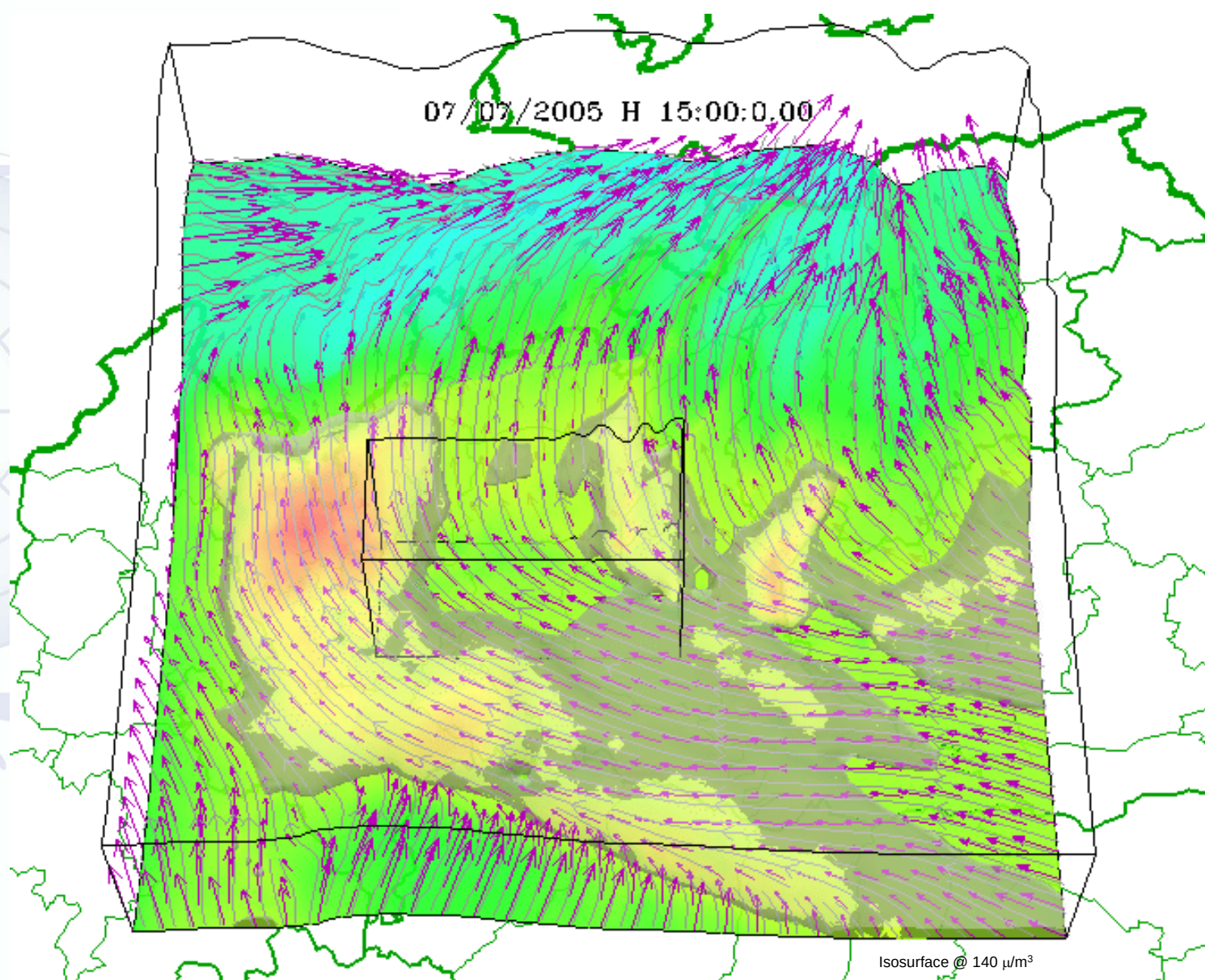


Broader context for AQM: chemical BC

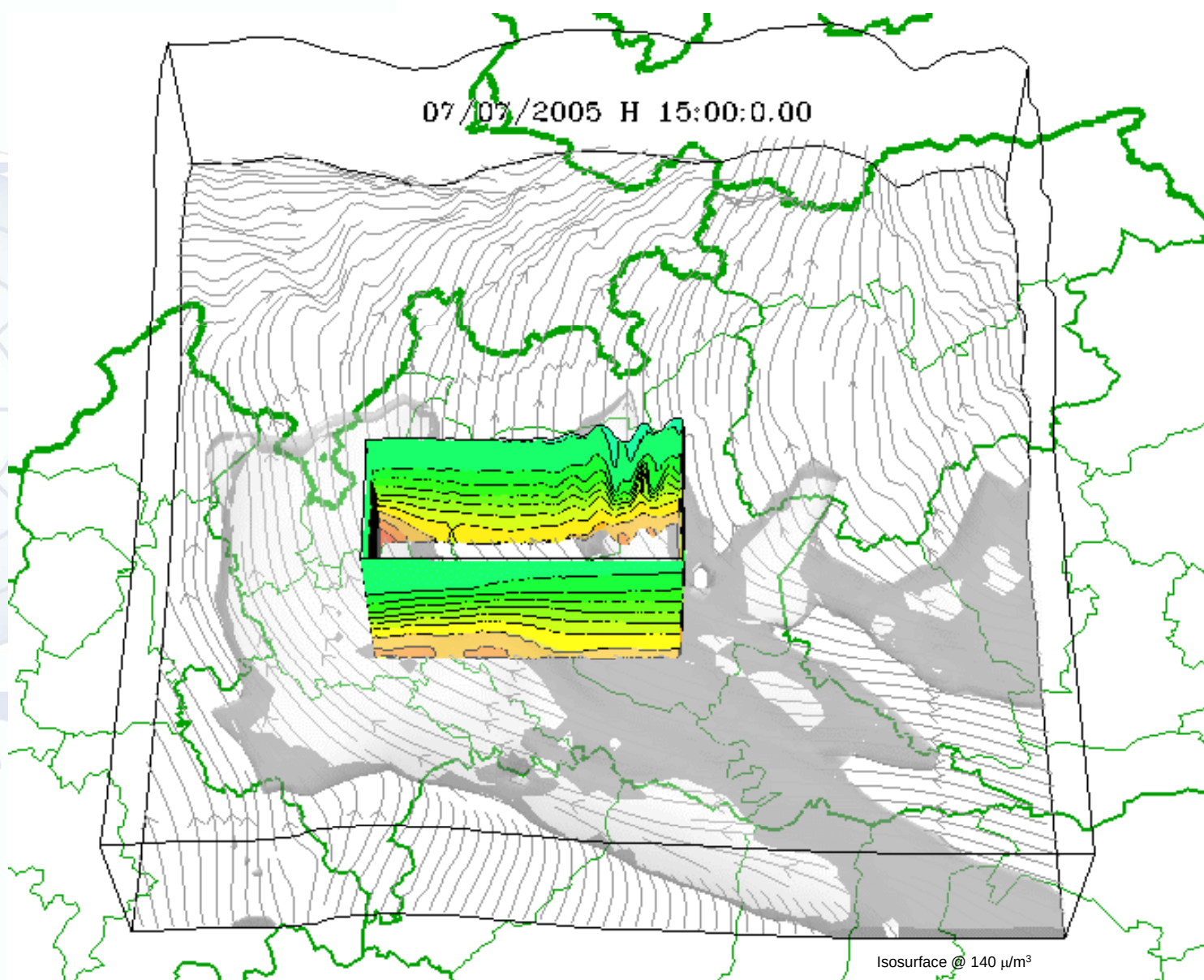
Nested simulation domains on Lombardia, N Italy



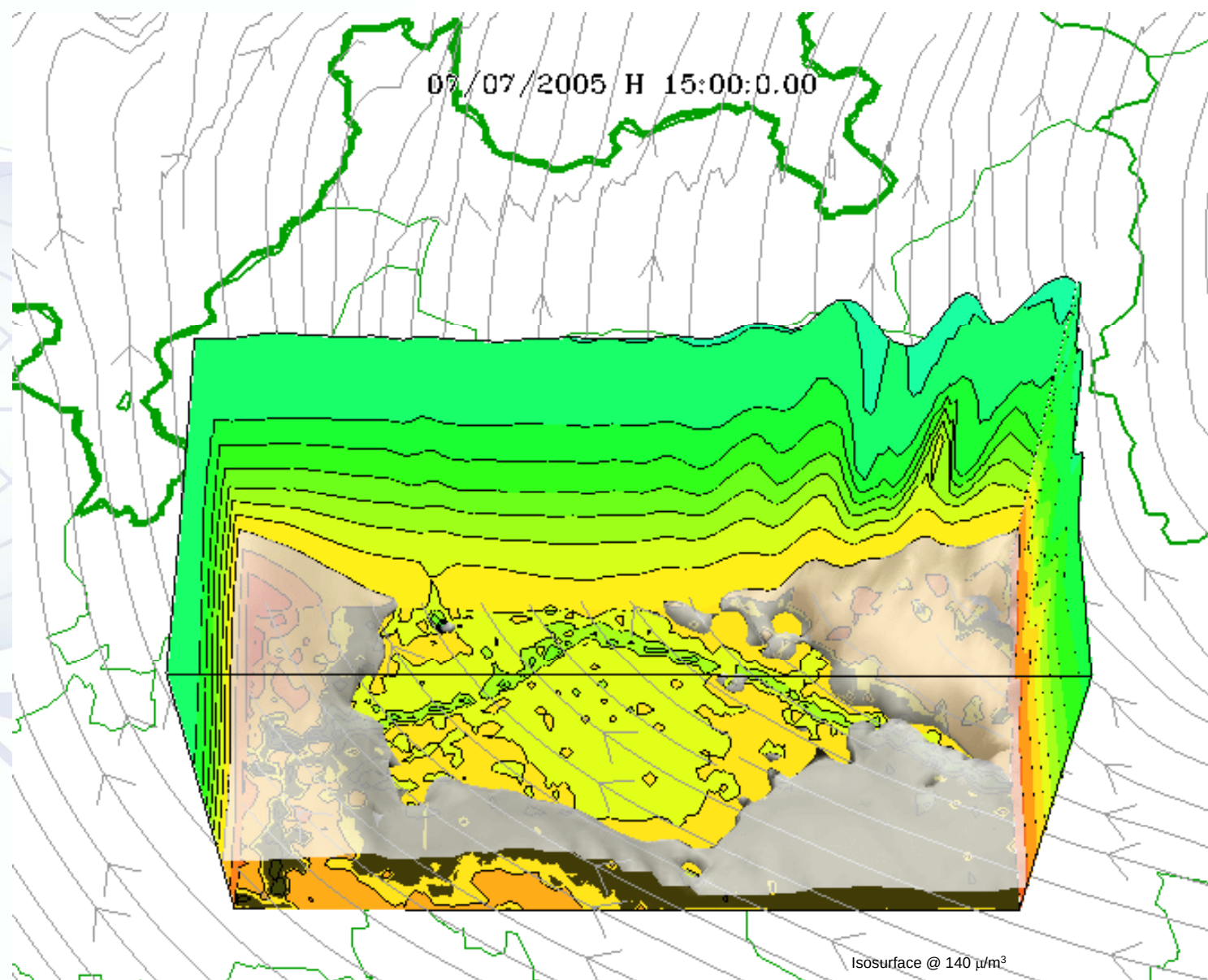
Concentrations on regional domain & wind



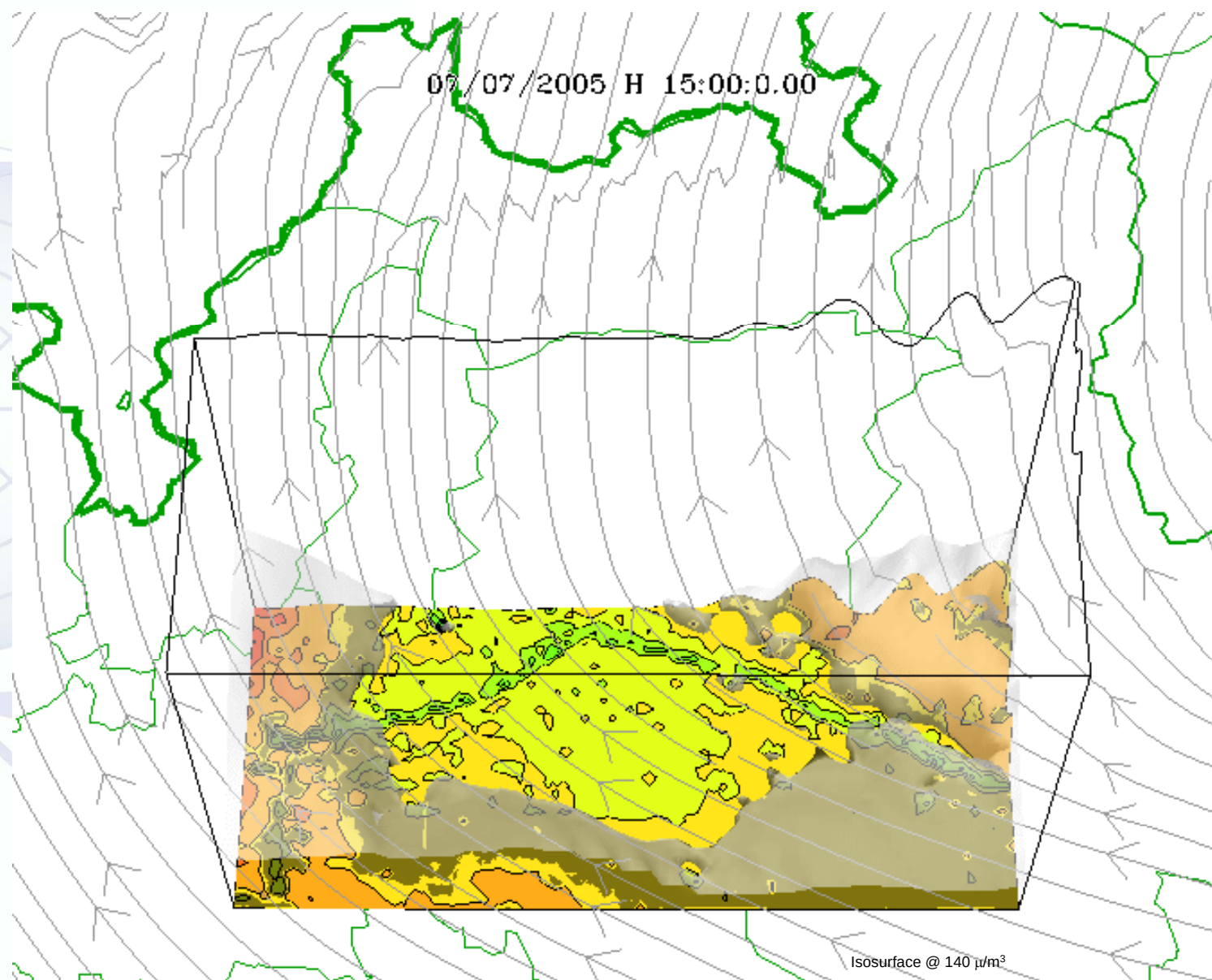
Regional domain $\Rightarrow$ BC for local domain



BC & concentrations on local domain



Concentrations on local domain



Chemical boundary conditions

- Larger scale model (regional / global)
- Time-varying / climatological
- Reprojection & extraction, species mapping
- Observations
- Data assimilation



Thank you