FAIRMODE SPATIAL REPRESENTATIVENESS: ANTWERP DATASET

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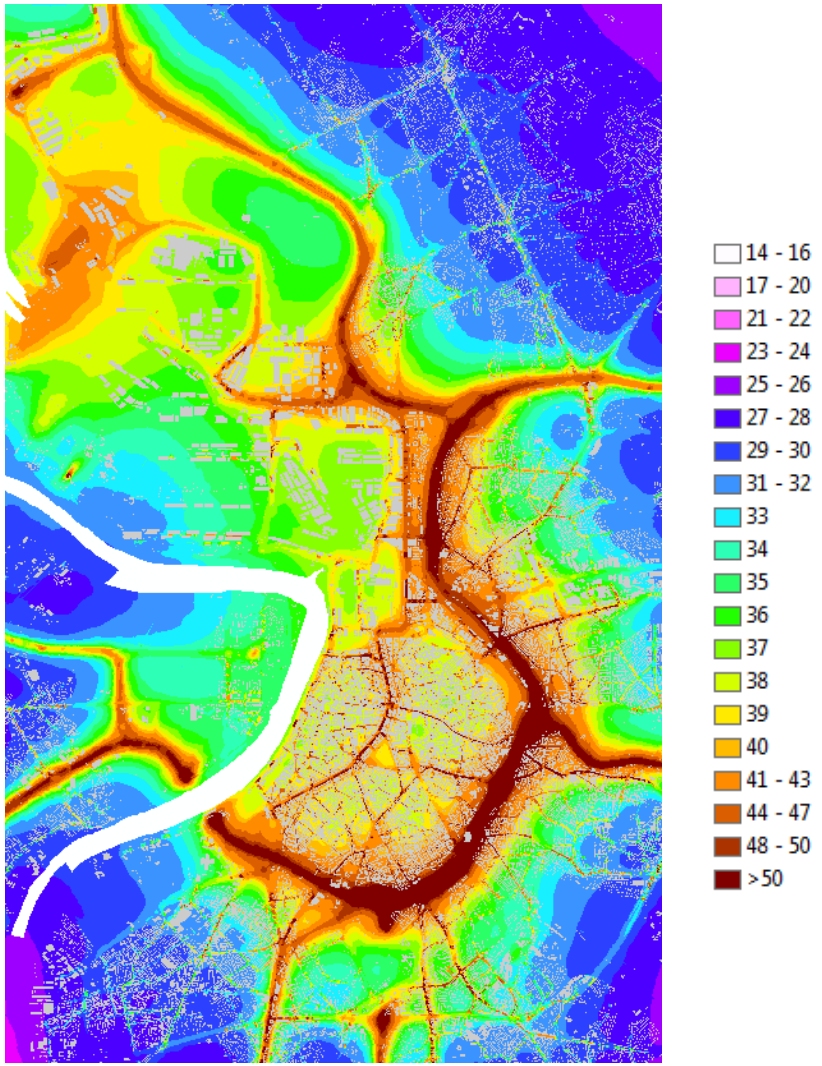
JRC
EUROPEAN COMMISSION

FAIRMODE
Forum for air quality modelling in Europe

OVERVIEW

- Spatial representativeness
- Data overview
- Measurements
- Emissions
- Model chain
  - Basic description
  - Model input
- Virtual stations
- Summary

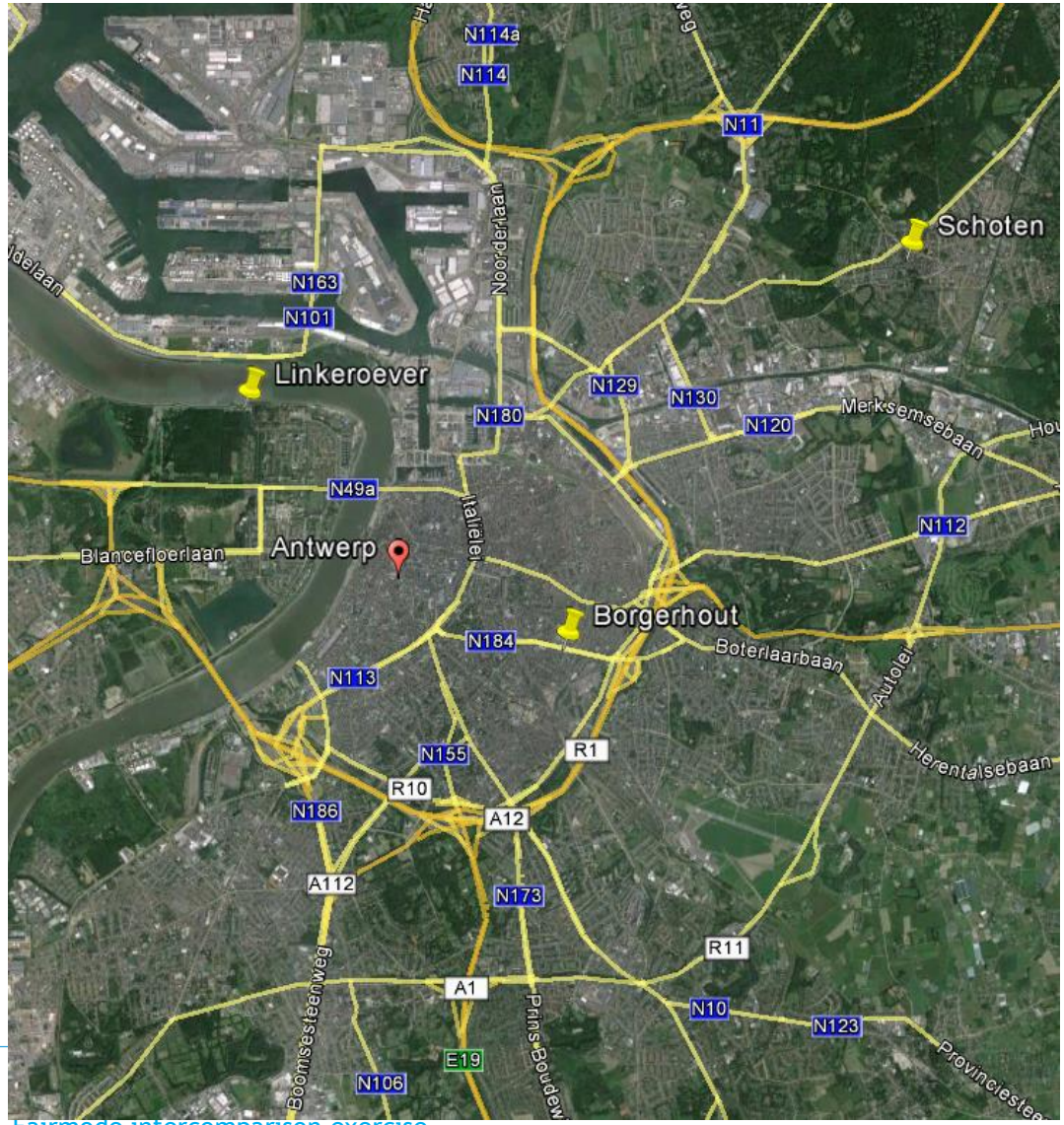


SPATIAL REPRESENTATIVENESS EXERCISE

- Focus on representativeness of three measurement stations in the Antwerp Area

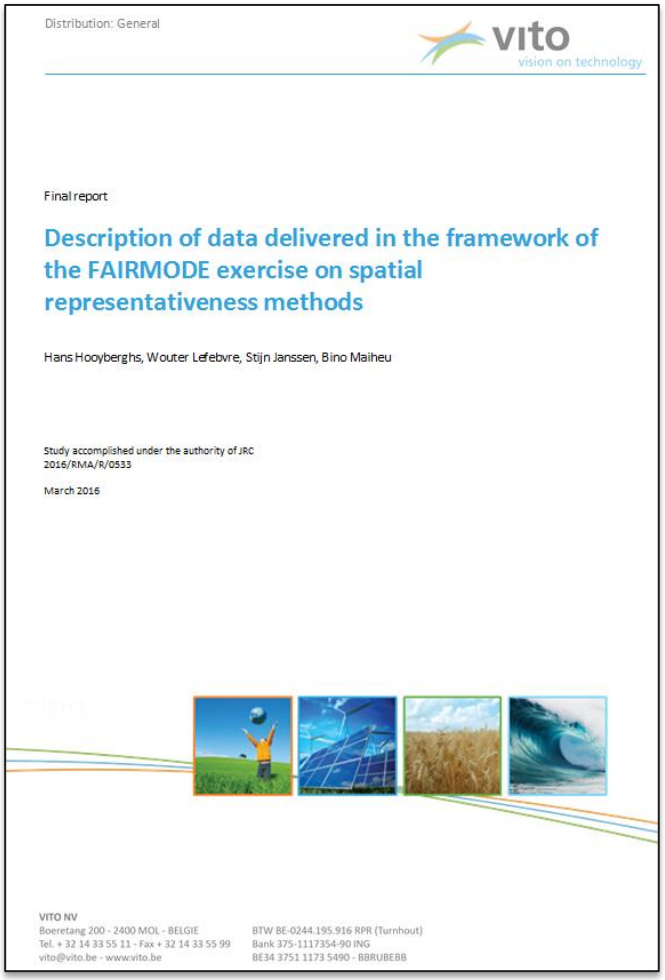
- Traffic site
  - Borgerhout II (street canyon location)

- Urban background sites
  - Antwerpen-Linkeroever
  - Schoten



DATA OVERVIEW

- Measurements
  - Telemetric stations (2012)
  - Campaigns with passive samplers and mobile stations (2012)
- Emissions
- RIO-IFDM-OSPM modelresults
- Various
  - Population density (100m x 100m)
  - Buildings
  - Corine Land Use


Distribution: General

vito
vision on technology

Final report

Description of data delivered in the framework of the FAIRMODE exercise on spatial representativeness methods

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Study accomplished under the authority of JRC
2016/RMA/R/0533

March 2016

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MEASUREMENTS

- 26 telemetric stations, yearlong data (2012)

Industrial	16
Urban / Industrial	1
Urban / Traffic	1
Urban / Traffic street canyon	1
Urban background	6
Urban background / Industrial	1

- Campaigns with passive samplers and mobile stations (2011 and 2012):
  - NO_2 and PM
  - 27 measurement periods of 14 days

Urban Background	2
Street canyon	2
Regional road	2

EMISSIONS

- Gridded emission data on 1x1km²
  - CO, NH_3, NMVOS, NO_x, PM_{10}, $PM_{2.5}$, So_x
  - SNAP-sectors
- Line sources for traffic emissions
  - Note that these emissions are also included in the 1x1km² gridded emissions, this file denotes how these emissions are spread across the roads in the grid cells
- Point sources
  - Annual total point source emissions for 2010 reported by the Belgian government in the scope of the CLRTAP-agreement (The 1979 Geneva Convention on Long-range Transboundary Air Pollution).
  - Since the point source data included in the 1x1km² gridded emissions differ slightly form the point source data in this file, one must take care in combining both datasets and apply a suited double counting procedure

Snap sector	Sector Description
1	Combustion in energy production and transformation
2	Non-industrial combustion plants
3	Combustion in manufacturing industry
4	Production processes
5	Extraction and distribution of fossil fuels and geothermal energy
6	Solvent use and other product use
7	Road transport
8	Other mobile sources and machinery
9	Waste treatment and disposal
10	Agriculture

POINT SOURCES

Comparison of data sets

» Total emissions in domain

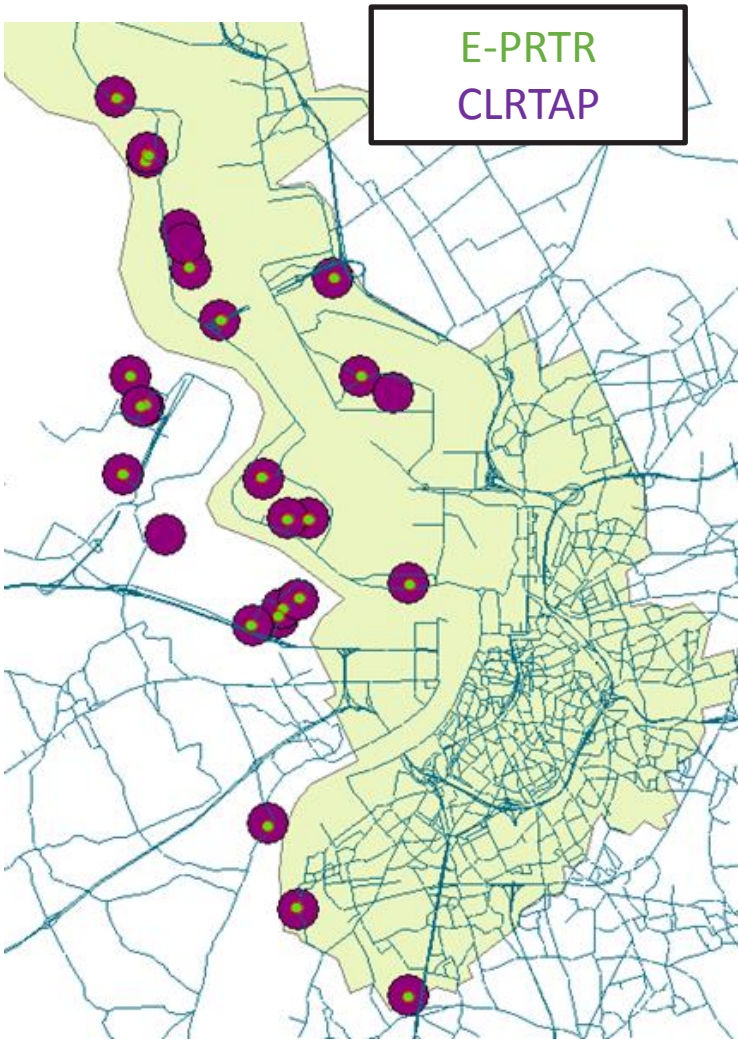
Ton/year	NO_x	PM_{10}	$PM_{2.5}$
Local dataset (2012)	12488	425	219
CLRTAP (2010)	12589	0	0
E-PRTR (2012)	11422	106	0

Note: According to our local dataset, only 8% of the PM_{10}-emissions are emitted at point sources.

» Height of emissions

Height category	Local dataset	CLRTAP
1 (h > 45m)	6125	6100
2 (45m < h < 100m)	5530	4590
3 (100m < h < 150m)	700	135
4 + 5 (h > 200m)	60	0
Unknown		1765

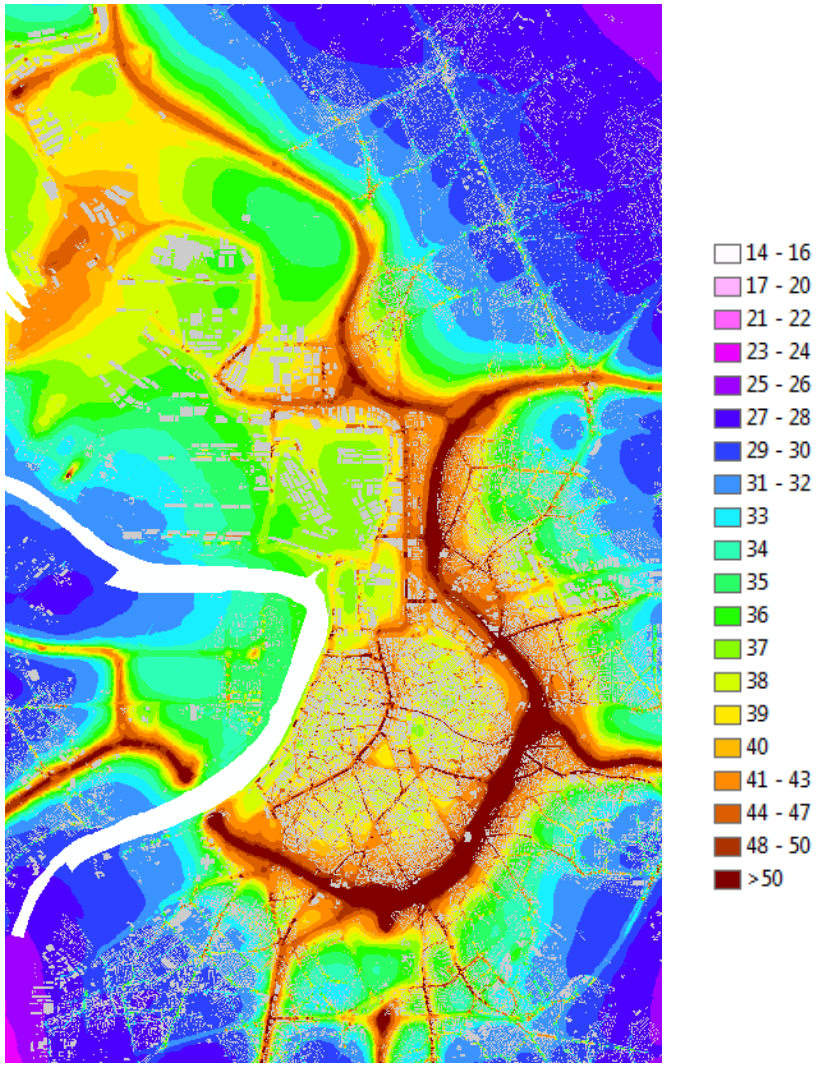
» Additional constraints:
  - » No height of stacks in E-PRTR
  - » No heat content in E-PRTR and CLRTAP
  - » Coordinates in local dataset are confidential



MODEL RESULTS

Description

- Model chain: RIO-IFDM-OSPM
- Year: 2012
- Pollutants: NO_2, BC, $PM_{2.5}$, PM_{10}, C_6H_6, O_3
- Results
  - Gridded annual mean concentrations
  - Time series for 341 (virtual) stations



MODEL RESULTS

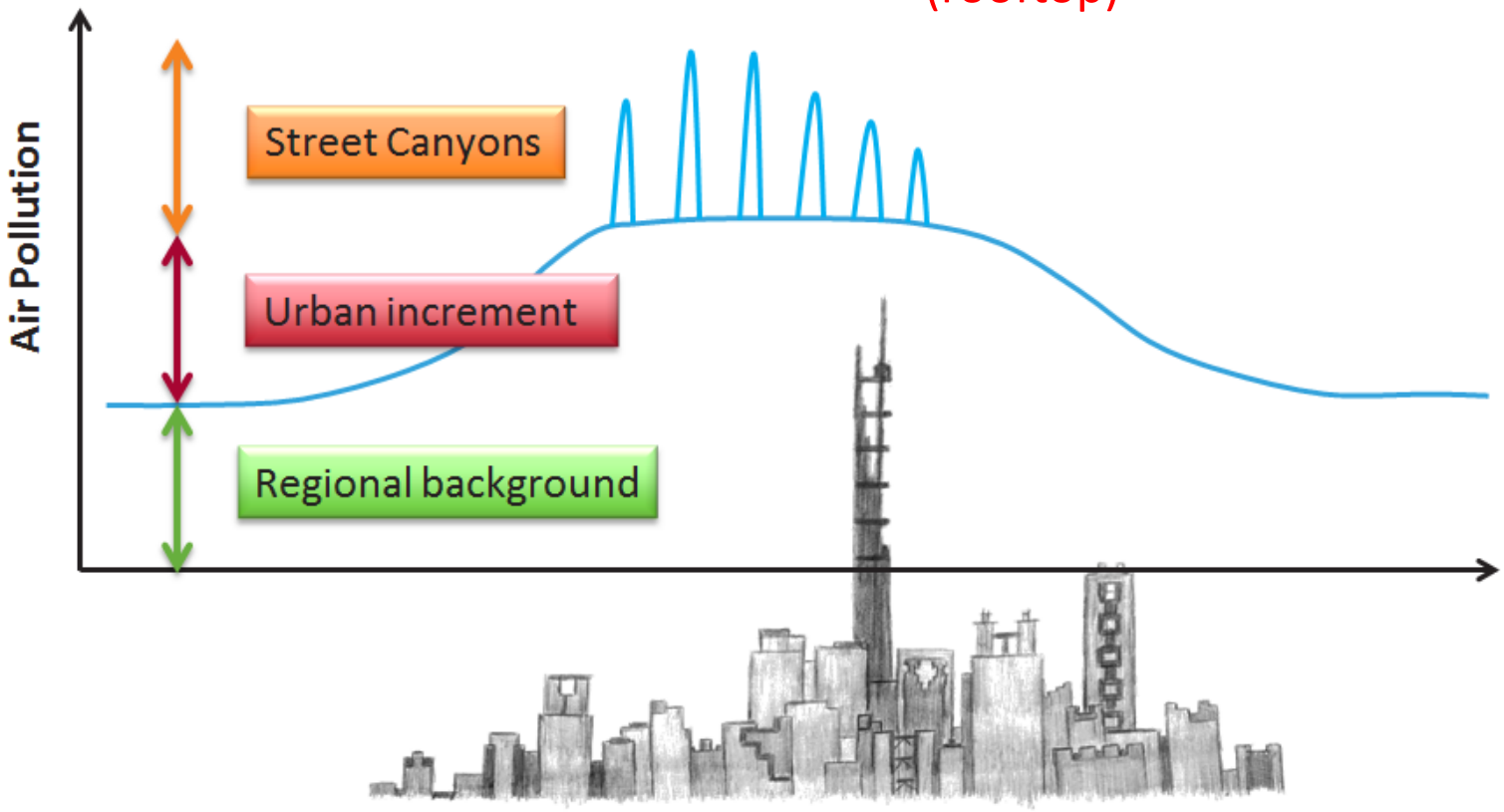
Model Chain

RIO - IFDM - OSPM chain

Regional background

Urban traffic and industrial point sources (rooftop)

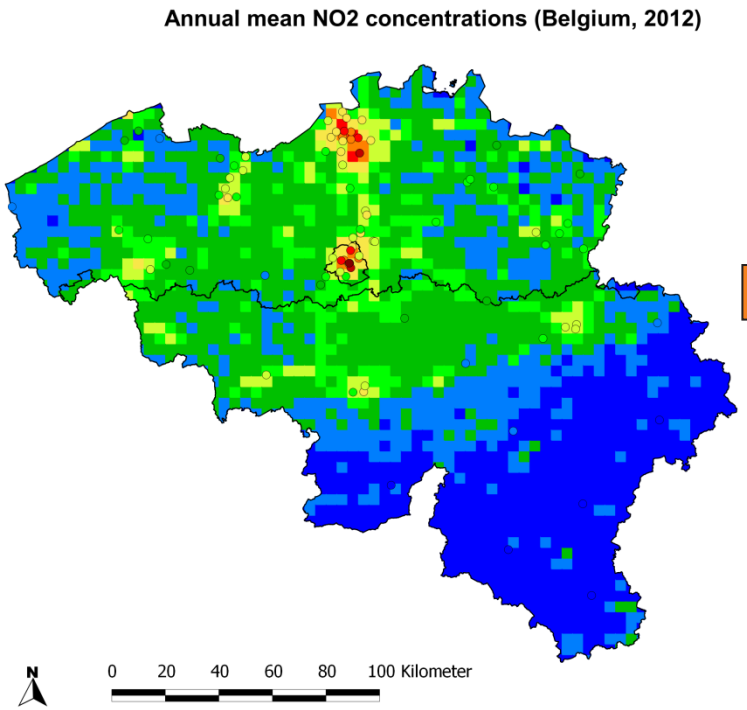
Street-canyon module

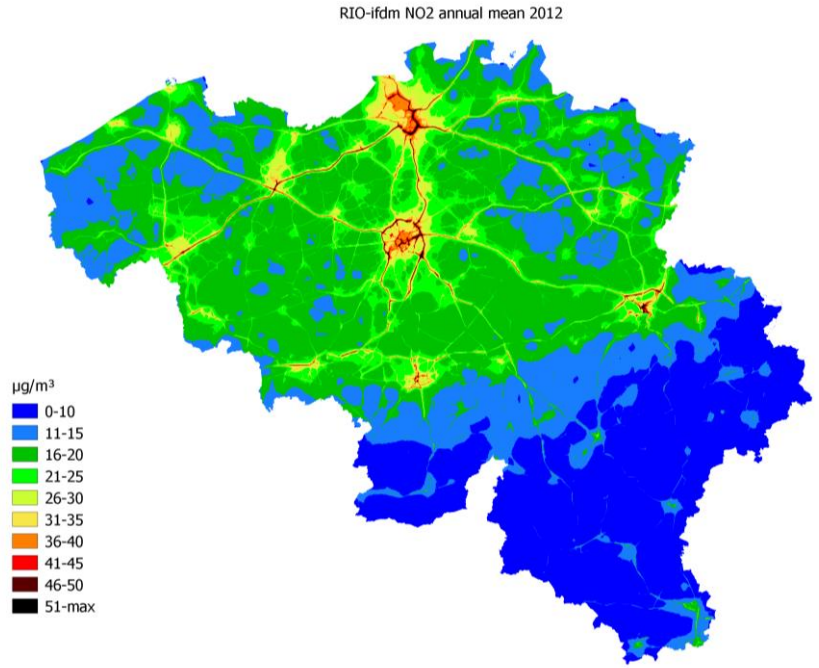


OVERVIEW I

RIO

RIO-IFDM



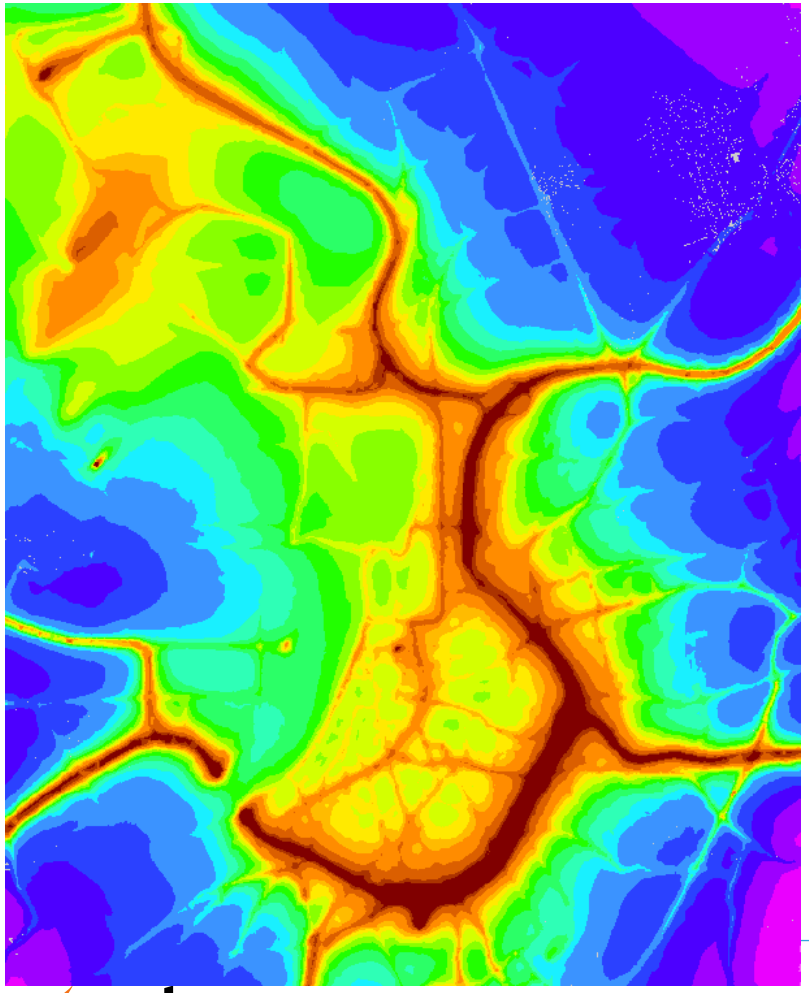


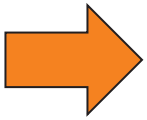
Data source: http://www.atmosys.eu

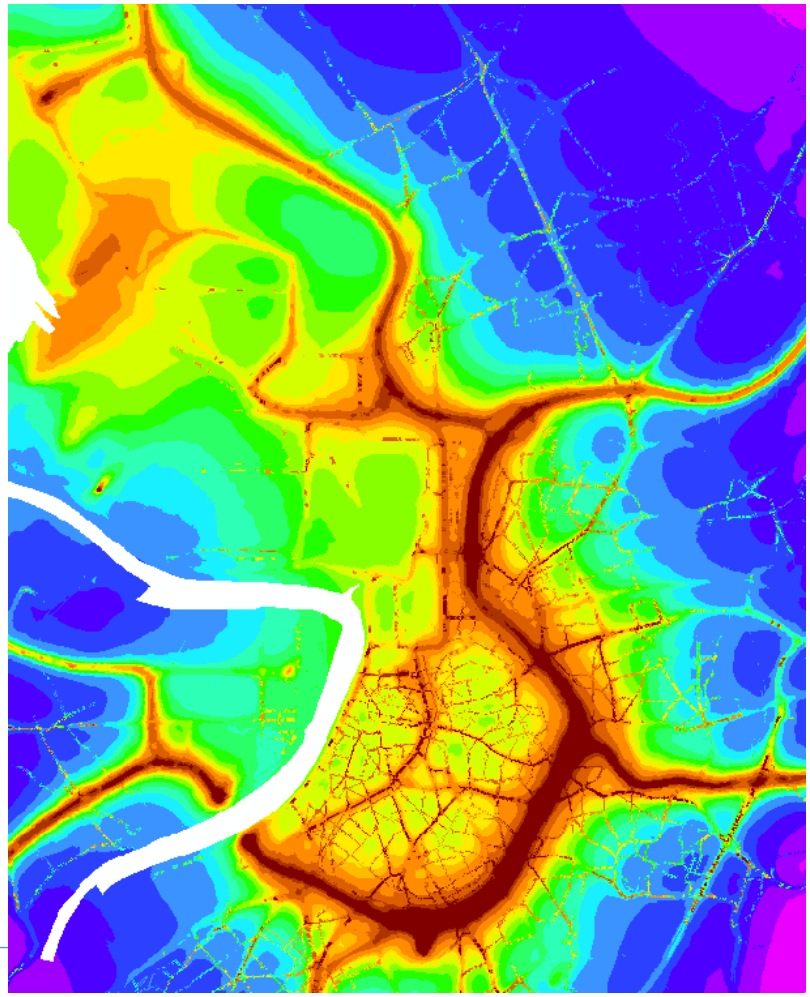
OVERVIEW II

RIO-IFDM

RIO-IFDM-OSPM

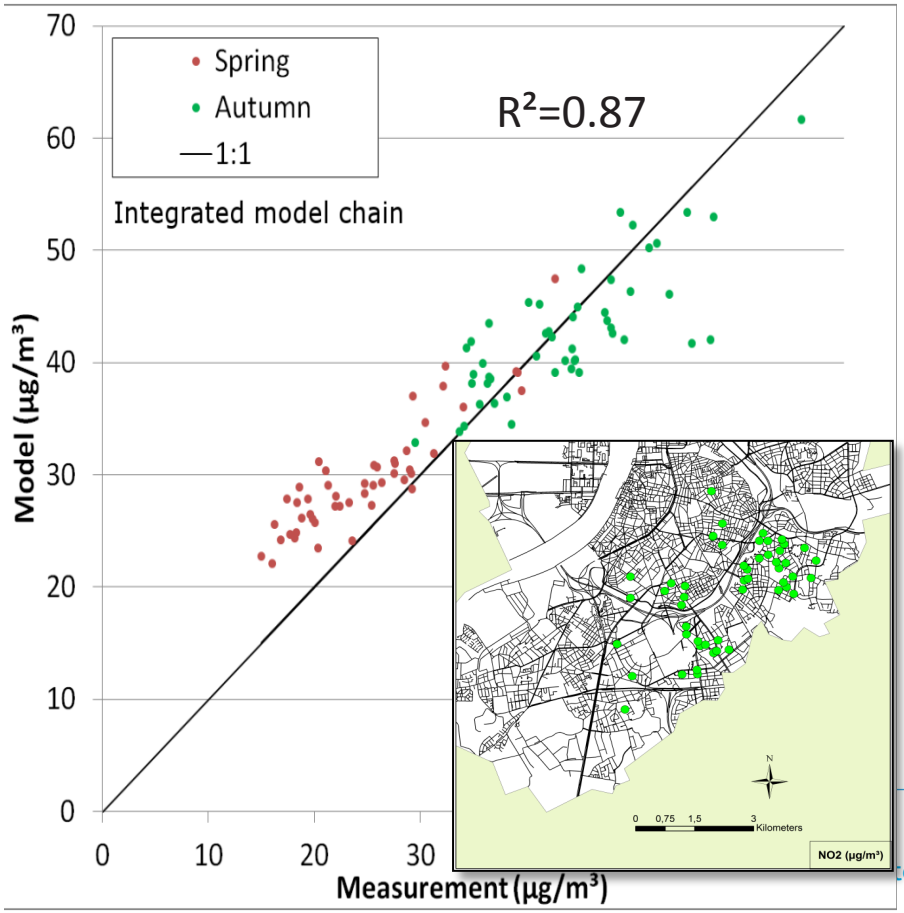


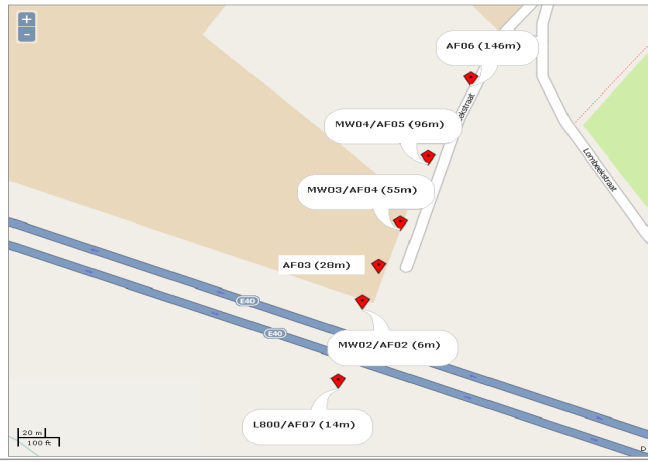


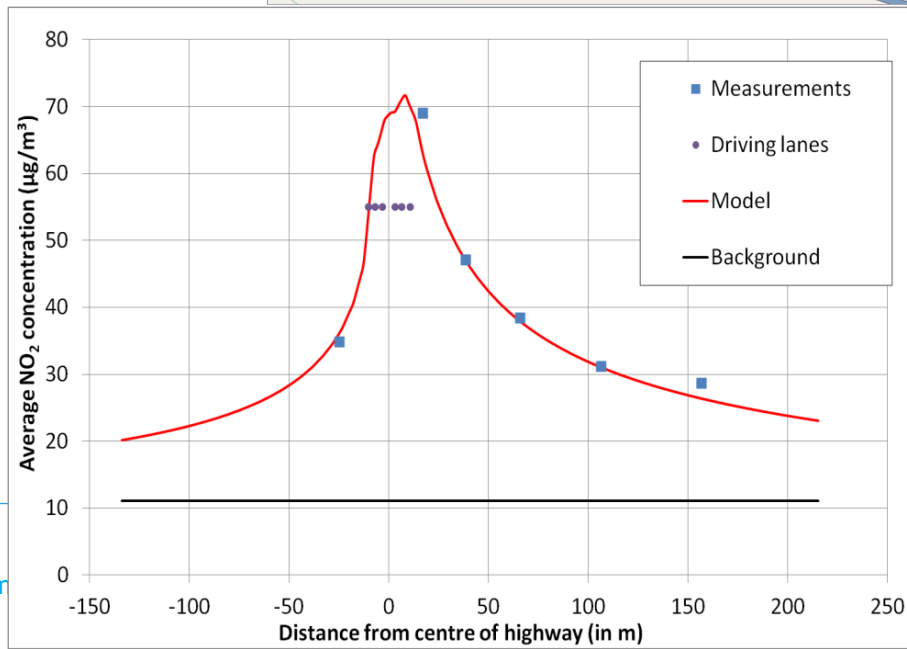


VALIDATION

- Model chain has been validated in many campaigns
  - City wide validation for Antwerp (NO_2)
  - Gradient validation close to highway (NO_2)
  - 5 chemKar campaigns for particulate matter (PM)





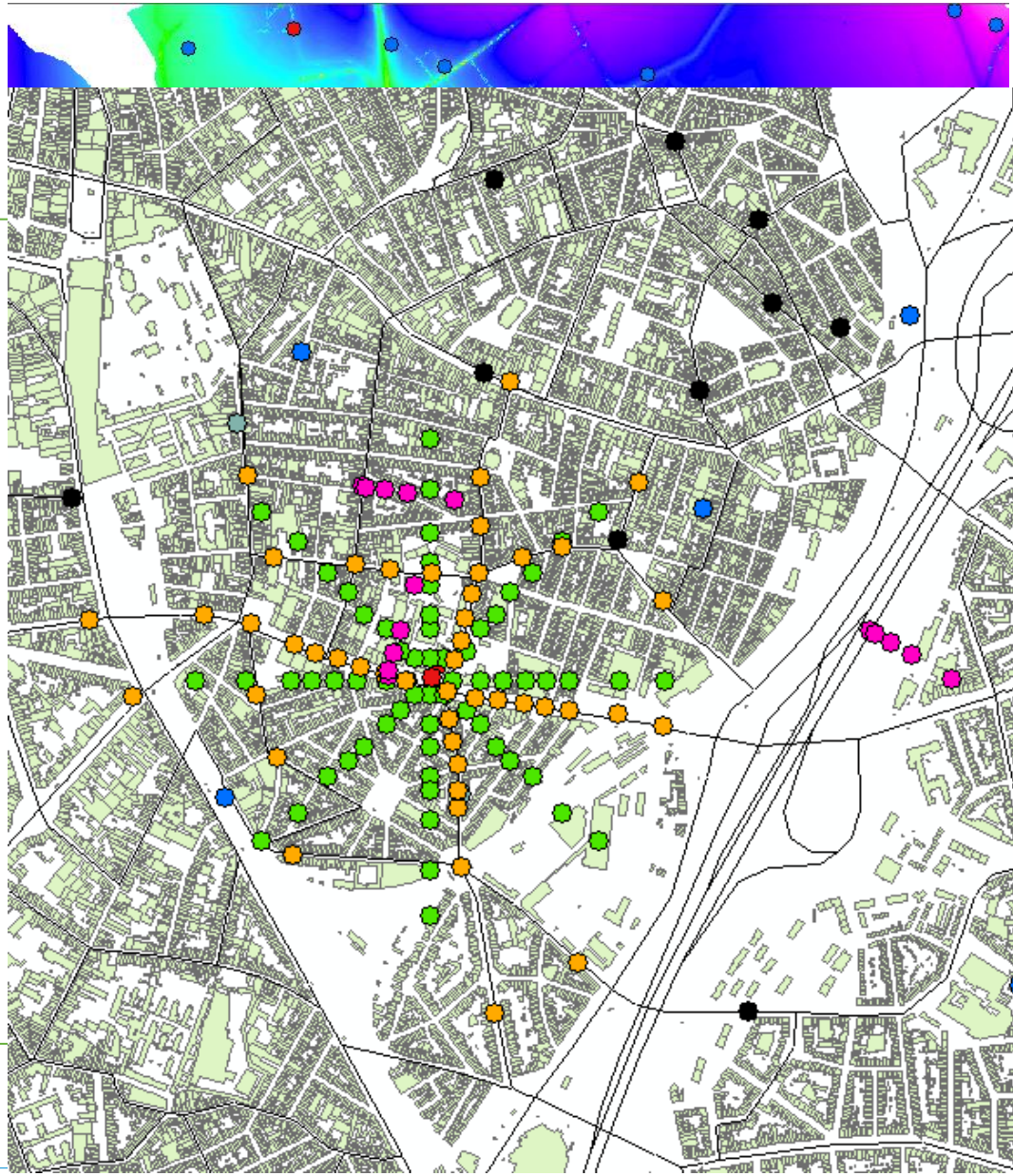


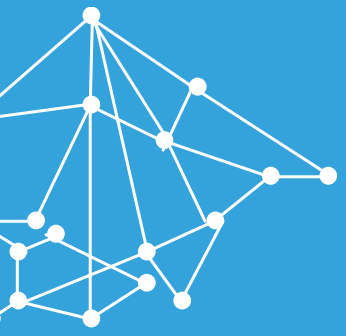
REMARKS

- Underestimation of PM concentrations in street canyons (related to multiple resuspension)
- No street canyon results for ozone (only rooftop concentrations)
- Due to the lack of benzene measuring stations, there is no RIO-background concentration. Hence, the benzene maps only show the local contribution of traffic and industrial point sources. Measurements at the Borgerhout measuring station indicate that the annual mean background concentration is approximately 0.7 µg/m^3.
- The point source dataset used in the modelling exercise and the one provided in the emission data differ slightly. Due to confidentiality agreements, VITO is not allowed to disclose its (high resolution) dataset, but the emissions of this dataset are included in the 1x1km^2 gridded emissions. A comparison between the CLRTAP dataset and the (confidential) local point source data is provided in the appendix of the report.

VIRTUAL MONITORING STATIONS

- Categories:
  - ATMOSYS campaign locations (6)
  - Telemetric stations (26)
  - Randomly chosen locations (117)
  - Randomly chosen street canyon locations (47)
  - Randomly chosen tunnel exit locations (4) [white]
  - Non-street canyon locations on concentric circles around Borgerhout stations (33)
  - Street canyon locations on concentric circles around Borgerhout stations (14)
  - Virtual gradient measurement at three locations (30)
- Total: 341 stations (100 in street canyon)





Questions?

EXTRA SLIDES

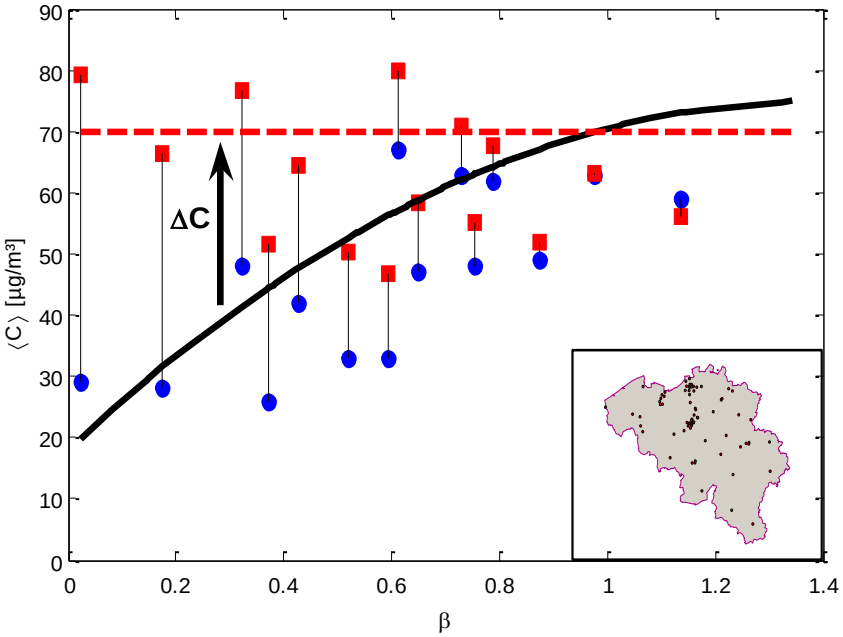
REGIONAL MODELLING: RIO

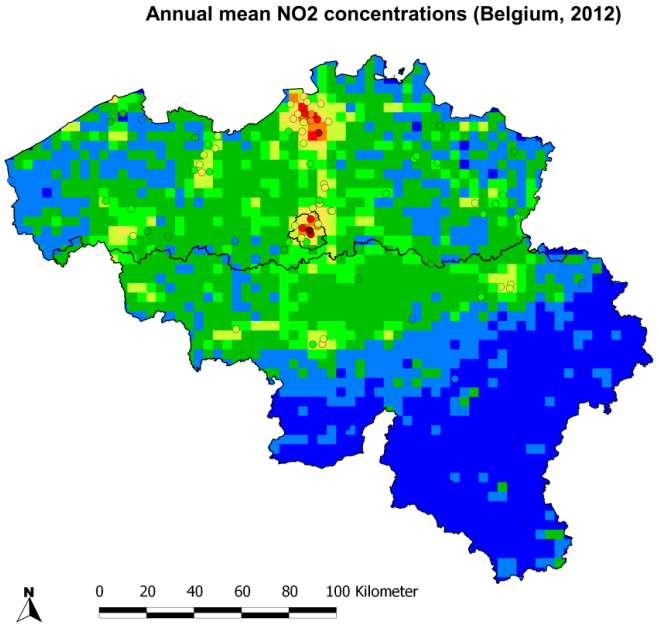
» Modelling technique based upon measurements

41B004	Brussel (Sint-Katelijne)	Bxl	59	7:00	13:00
41B006	Brussel (EU Parlement)	Bxl	62	3:00	12:00
41B008	Brussel (Belliardstraat)	Bxl	75	11:00	13:00
41B011	Sint-Agatha-Berchem	Bxl	56	1:00	13:00
41MEU1	Neder-Over-Heembeek	Bxl			6:30
41N043	Voorhaven (Haren)	Bxl	61	7:00	13:00
41R001	Sint-Jans-Molenbeek	Bxl	69	7:00	13:00
41R002	Elsene	Bxl	59	3:00	13:00
41R012	Ukkel	Bxl	43	3:00	13:00
41WOL1	Sint-Lambrechts-Woluwe	Bxl	53	7:00	13:00
4.70E+14	Vorst	Bxl	53	2:00	11:00
44M705	Roeselare (Haven)	Vla	41	8:00	10:30
44N012	Moerkerke	Vla	28	11:00	13:00
44N029	Houtem (Veurne)	Vla	18	3:00	13:00
44N052	Zwevegem	Vla	52	11:00	13:00
47E714	Dudzele	Vla	26	10:00	13:00
47E715	Zuienkerke	Vla	29	3:00	13:00
42R821	Beveren Waas	Vla	54	7:00	13:00
42R830	Doel (Scheldemolenstraat)	Vla	51	4:00	13:00
42R892	Kallo (sluis Kallo)	Vla	61	1:00	13:00
44M702	Ertvelde	Vla	46	5:00	13:00
44N051	Idegem	Vla	49	9:00	13:00
44R701	Gent	Vla	50	6:00	13:00
44R702	Gent (Gustaaf Callierlaan)	Vla	56	6:00	13:00
44R710	Destelbergen	Vla	49	6:00	13:00
44R721	Wondelgem	Vla	51	11:00	13:00
44R731	Evergem	Vla	46	8:00	13:00
44R740	Sint-Kruiswinkel	Vla	56	5:00	13:00
44R750	Zelzate	Vla	49	4:00	13:00
47E703	Oost-Eeklo	Vla	43	8:00	13:00
47E704	Wachtebeke	Vla	47	4:00	13:00
47E716	Mariakerke	Vla	48	9:00	13:00
40AL01	Antwerpen-Linkeroever	Vla	60	1:00	13:00
40HB23	Hoboken	Vla	65	1:00	13:00
40LD01	Laakdal	Vla	45	13:00	13:00
40LD02	Geel	Vla	23	1:00	13:00
40R833	Stabroek	Vla	46	2:00	13:00
42M802	Antwerpen (Luchtbal)	Vla	61	2:00	13:00
42N016	Dessel	Vla	36	1:00	13:00
42R801	Borgerhout	Vla	66	1:00	13:00

RIO METHODOLOGY

- Main question: How to make reliable maps based upon the measurements ?
  - Higher values in urban areas
  - Lower values in rural areas
  - Simple interpolation is insufficient
- Solution: use of Corine land use data
- Steps
  - Detrending: removal of land use bias in measurements
    Result: “homogeneous” concentrations at measurements stations
  - Interpolation
    Result: “homogeneous” map of concentrations
  - Retrending: re-adding the land use bias
    Result: concentration map



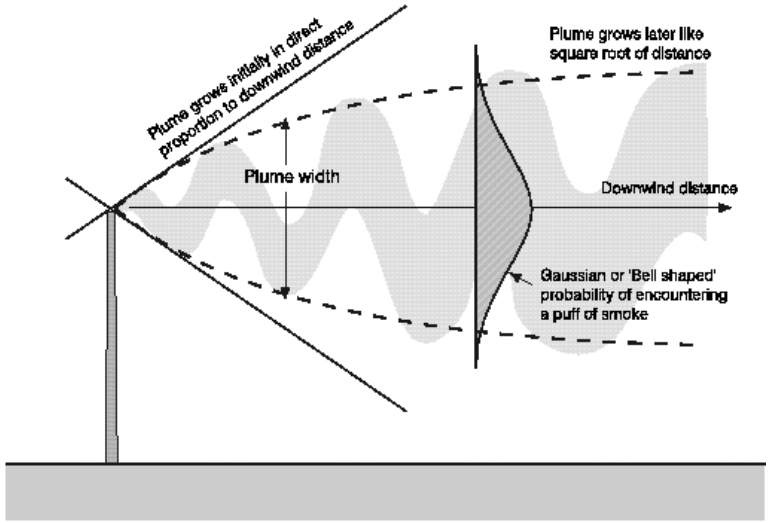


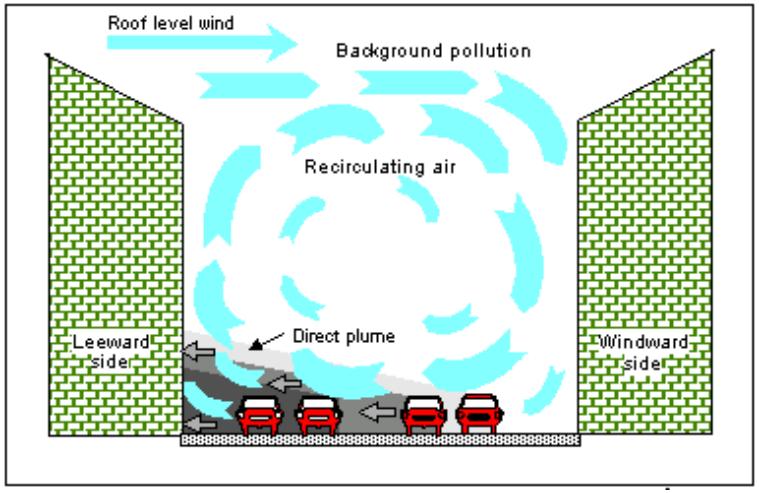
LOCAL MODELLING

IFDM
Urban scale traffic

Double-counting procedure

OSPM
Street-canyon module





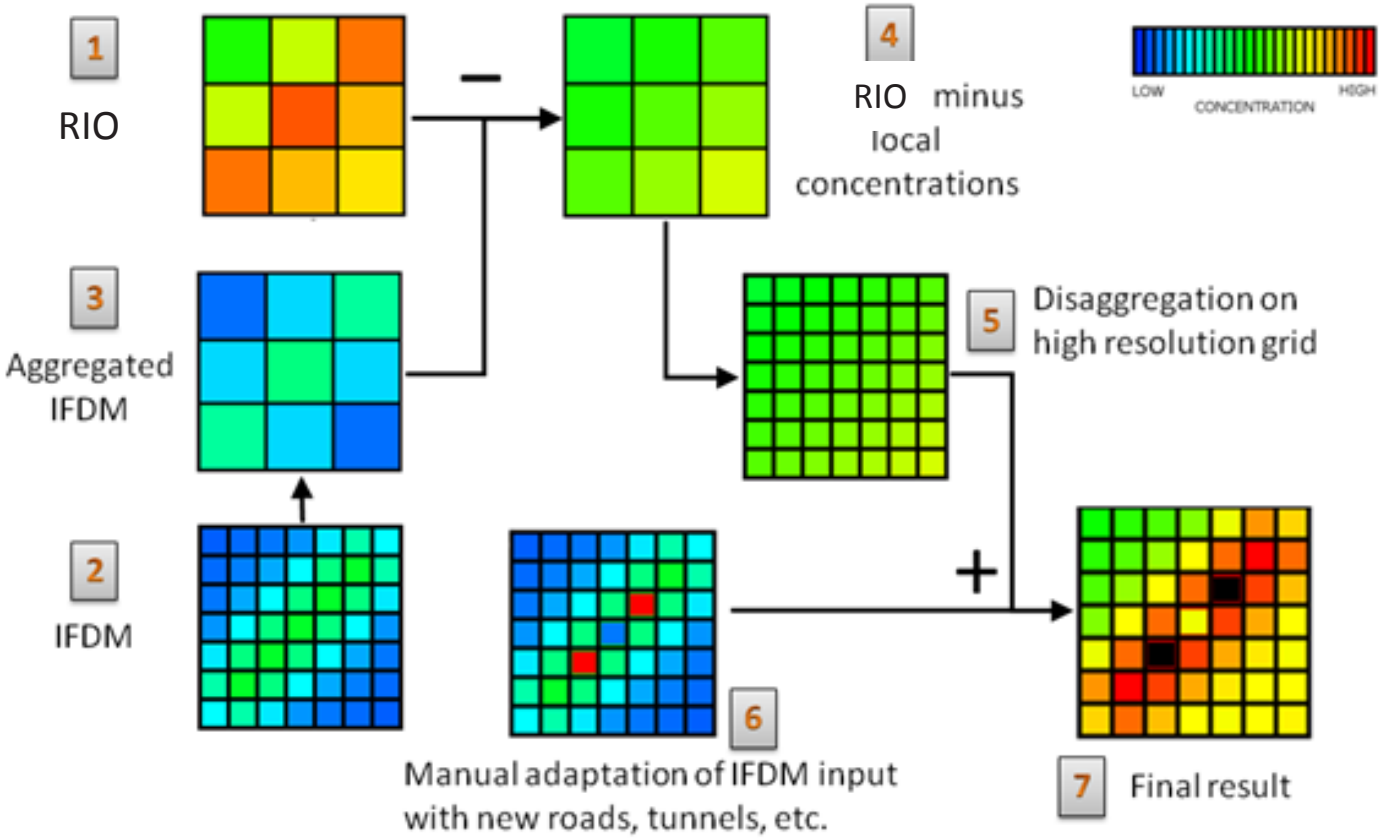
- Plume model
- Gaussian dispersion, taking into account the stability of the atmosphere using stability classes (based on meteorological input)
- Receptor model

- Box model for the recirculating part of the pollutants in the street canyon (resuspension)
- For simplicity: asymmetry of street canyon is neglected

Lefebvre, W. et al. (2011), Atm. Env., 45, p. 6705-6713

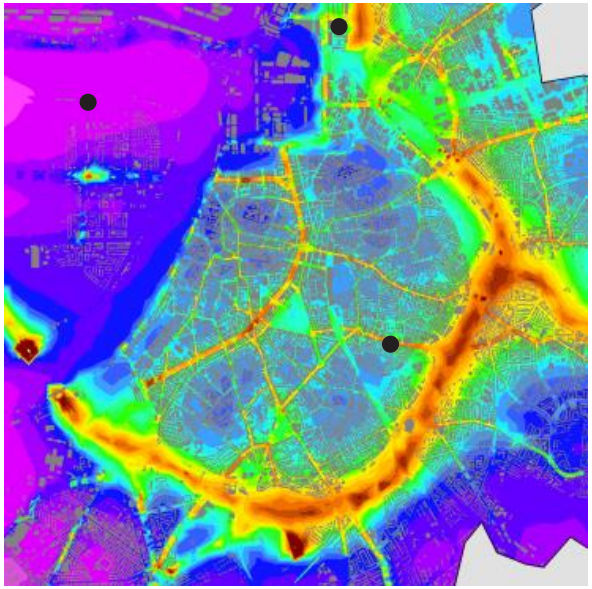
Berkowicz, R. (2000), Environmental Monitoring and Assessment, 65, pp. 323-331.

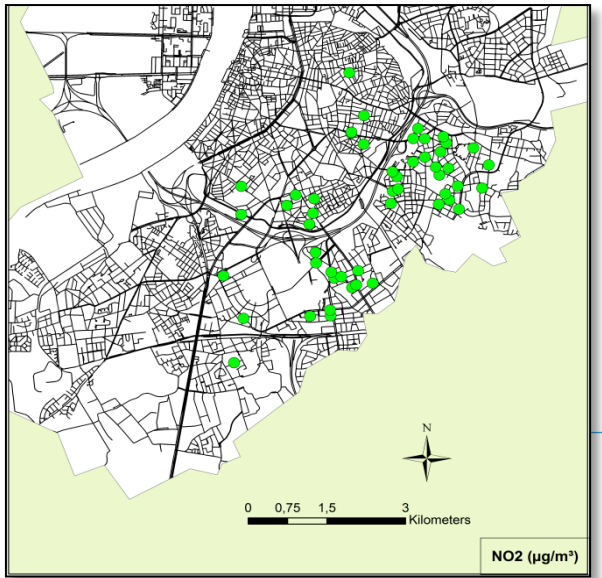
PROCEDURE TO AVOID DOUBLE COUTING

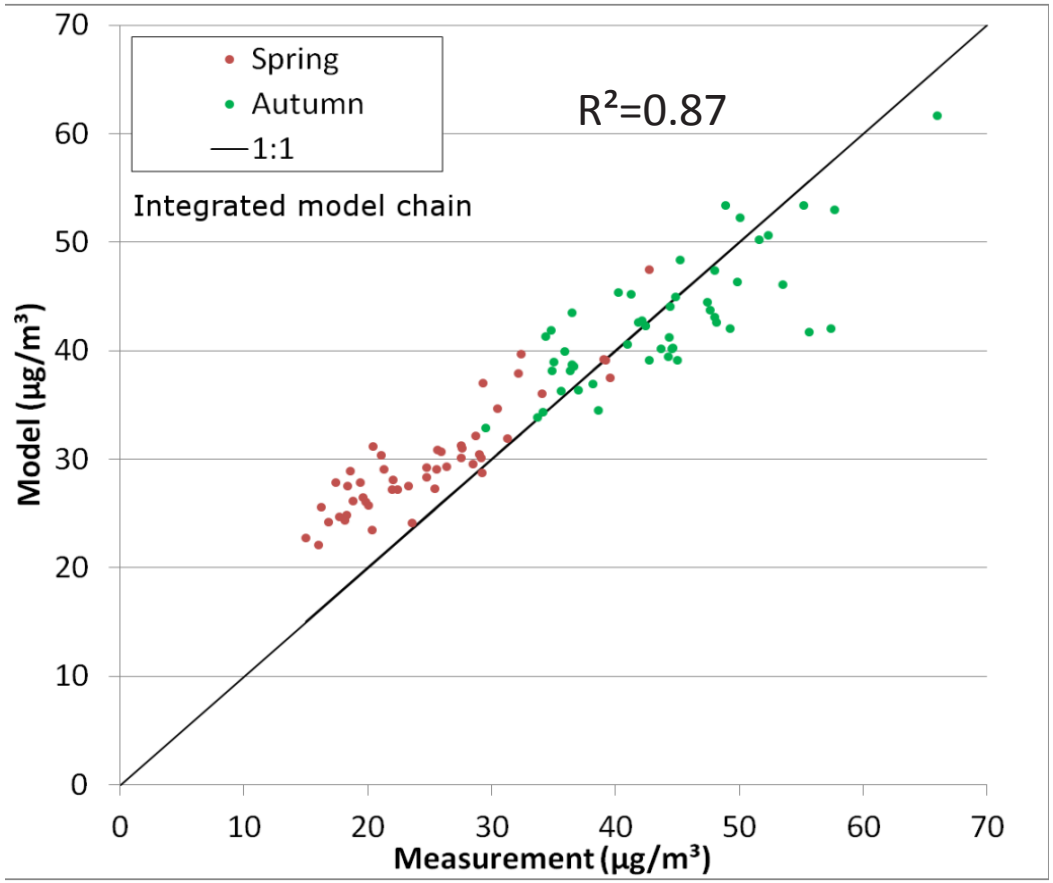


VALIDATION CAMPAIGNS

Urban scale validation campaign







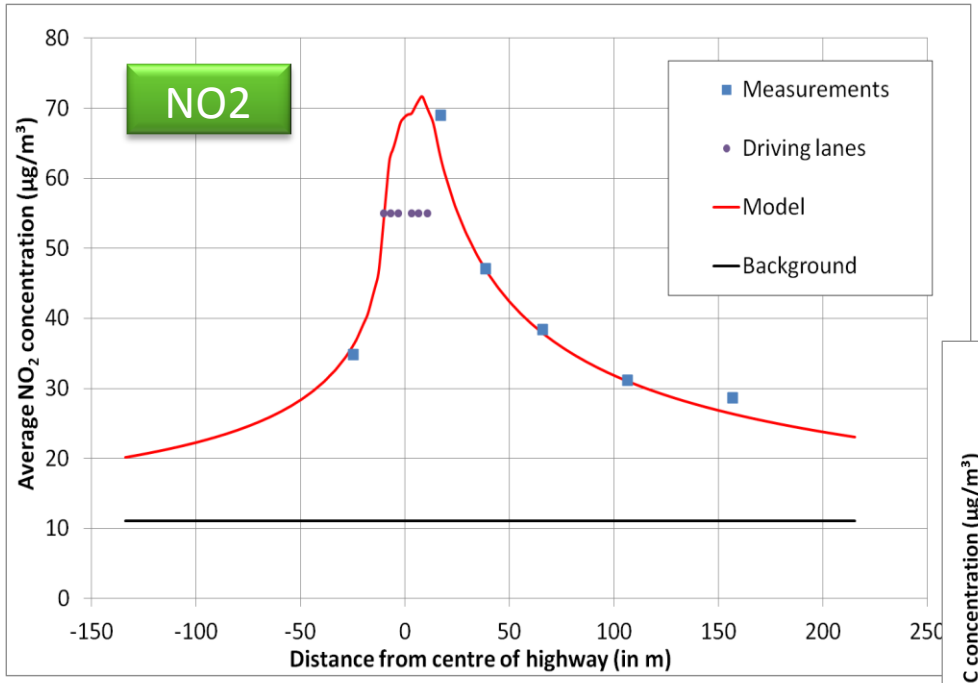
Lefebvre, W. et al. (2013), Atm. Env., 77, p. 325-337

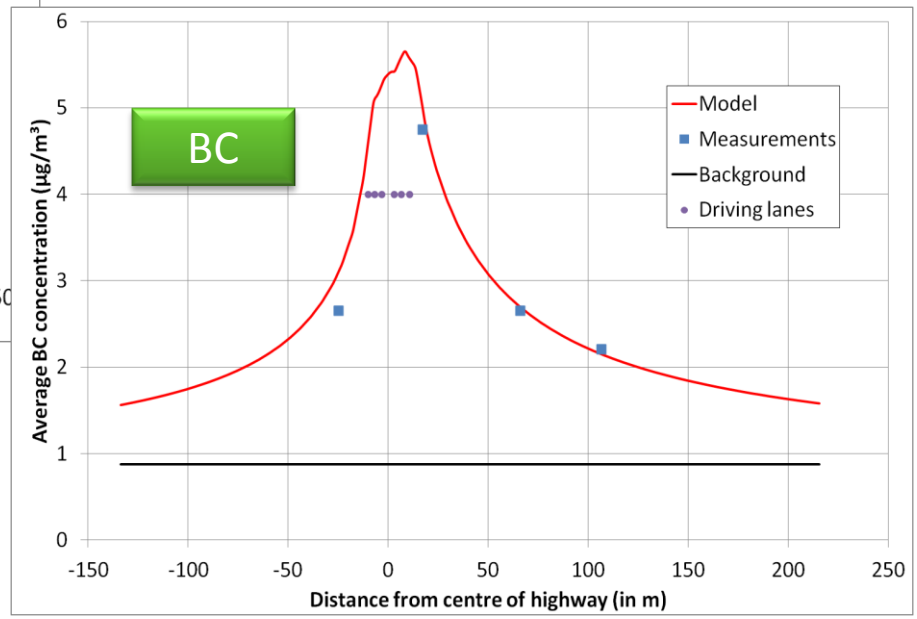
VALIDATION CAMPAIGNS

Highway measurement campaign

VALIDATION CAMPAIGNS

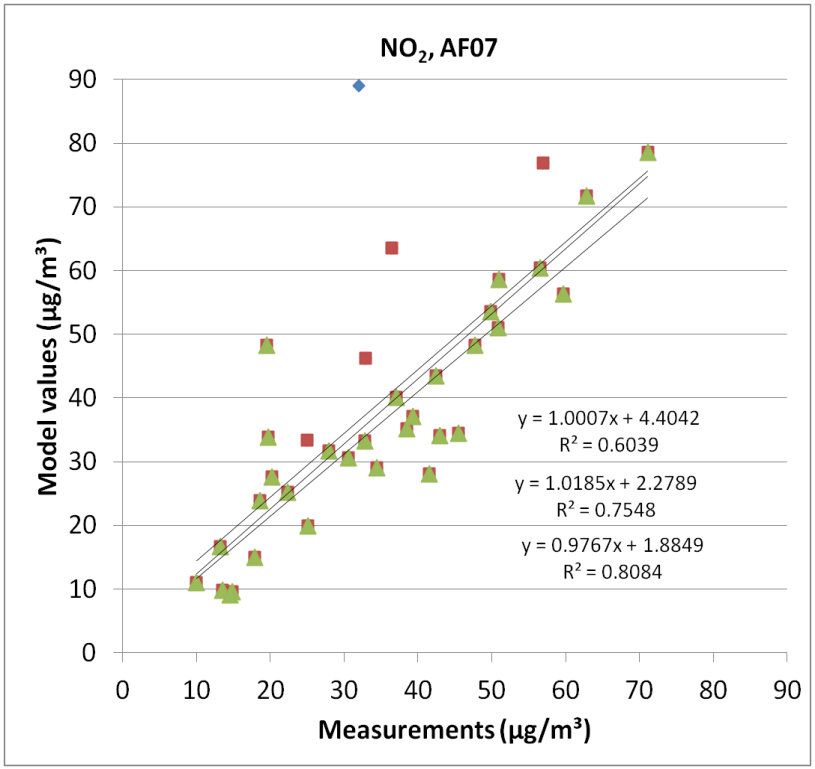
Highway campaign, spatial validation



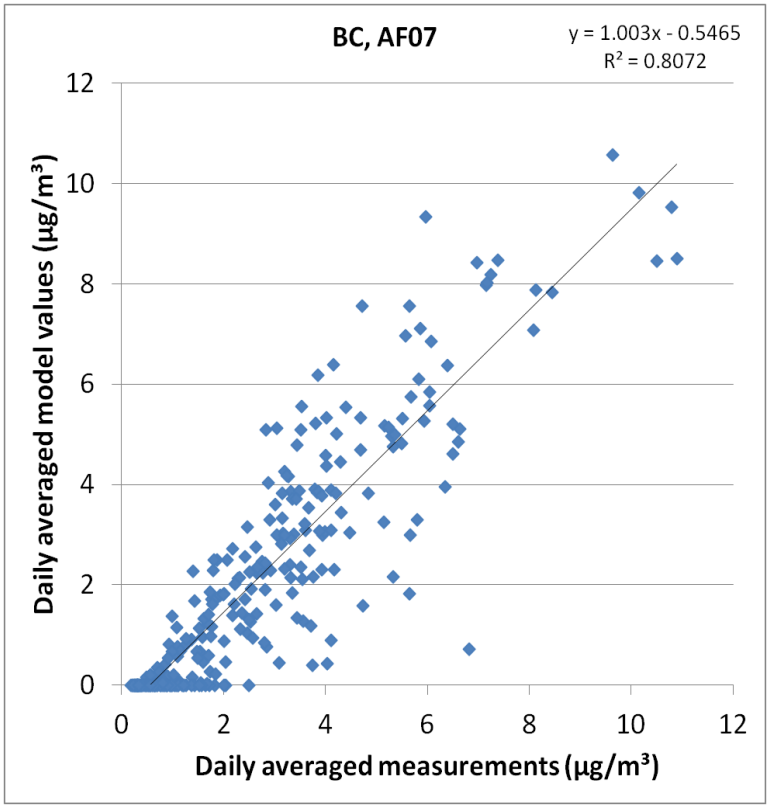


VALIDATION CAMPAIGNS

Highway campaign, temporal validation



NO2, weekly



BC, daily