

# RIO: a novel approach for air pollution mapping

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**HARMO 12**

**Cavtat - Croatia, 6 – 9 October, 2008**



# Introduction

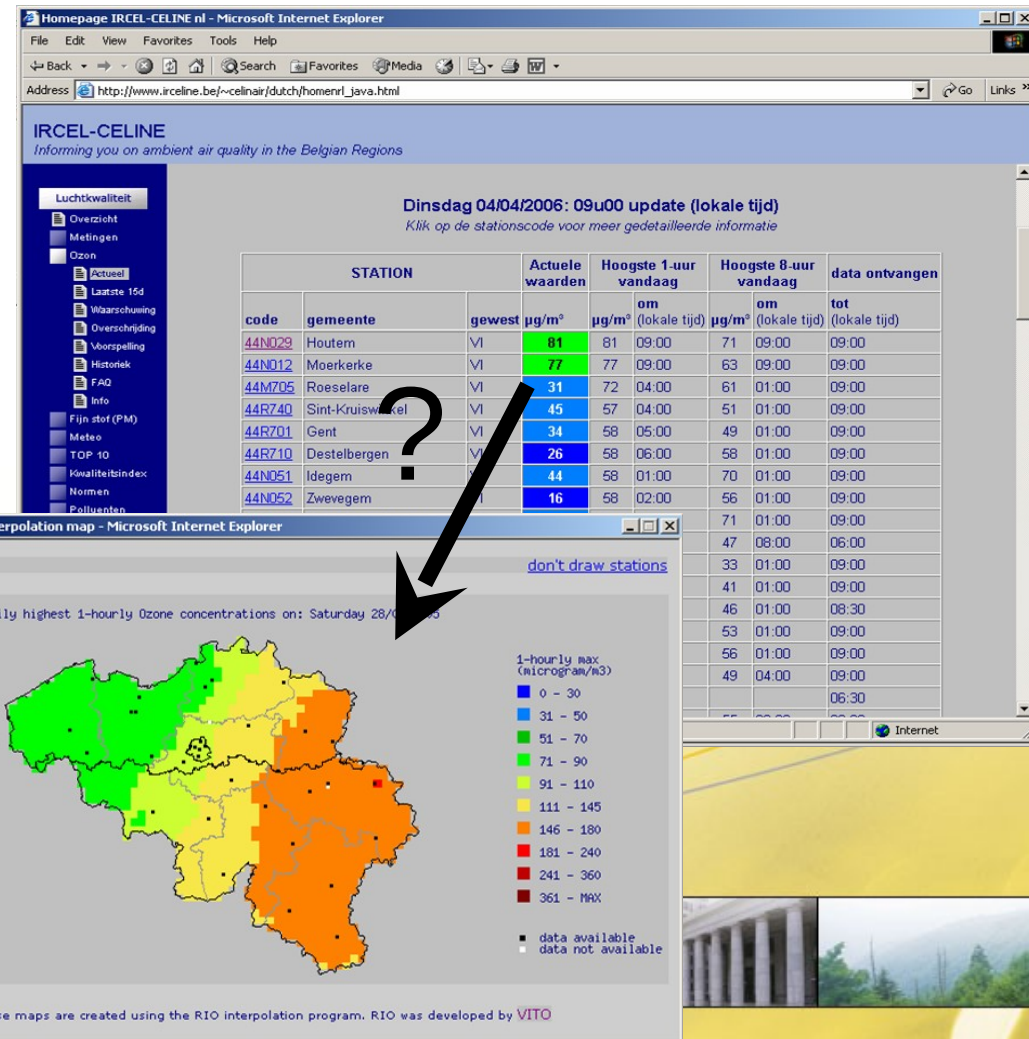
- Belgium is a rather small country with highly **urbanized regions**
- Air pollution is a **serious problem** in some regions
- **EU air quality standards** are not met everywhere



# Introduction

- Air quality is sampled by a **dense network** of monitoring sites
  - e.g. about 60 to 70 stations for NO<sub>2</sub> and PM<sub>10</sub> in Belgium
- Real-time measurements are **published one-line** by IRCEL
- Need for **reliable maps** to inform the public in near real-time
- How to **create** an air quality map from point values?

➤ Use a model



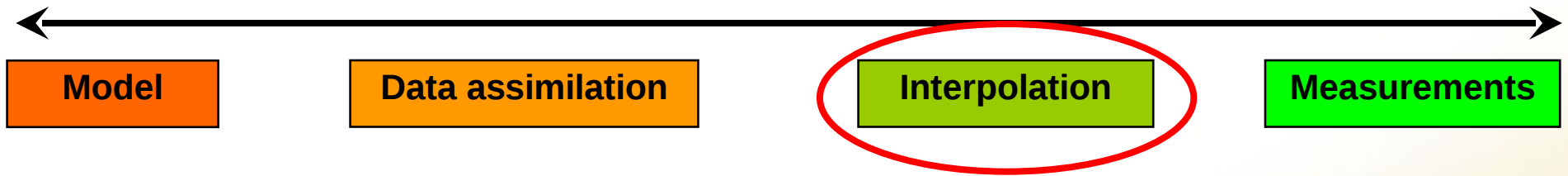
# Introduction

- According to EU Directives:
  - Air quality assessment for entire **air quality zones**
  - Indicator for **human exposure**
- Need for **reliable maps** with annual averages and statistics



# Introduction

- A wide variety of tools is available for an Environment Agency to accomplish these tasks

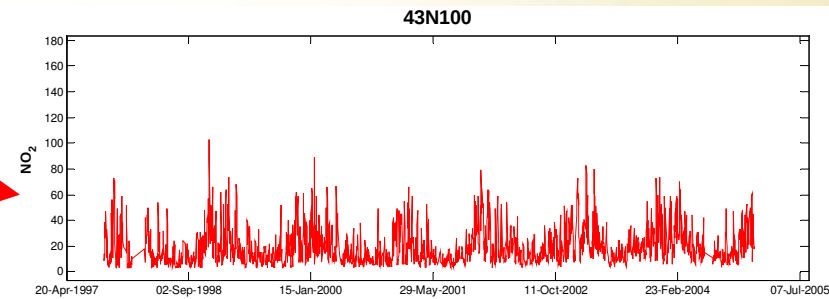
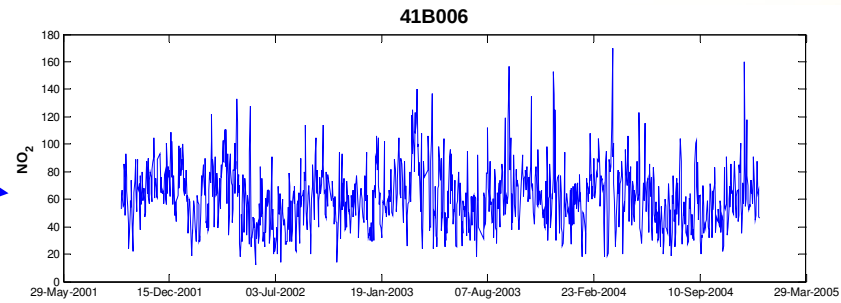
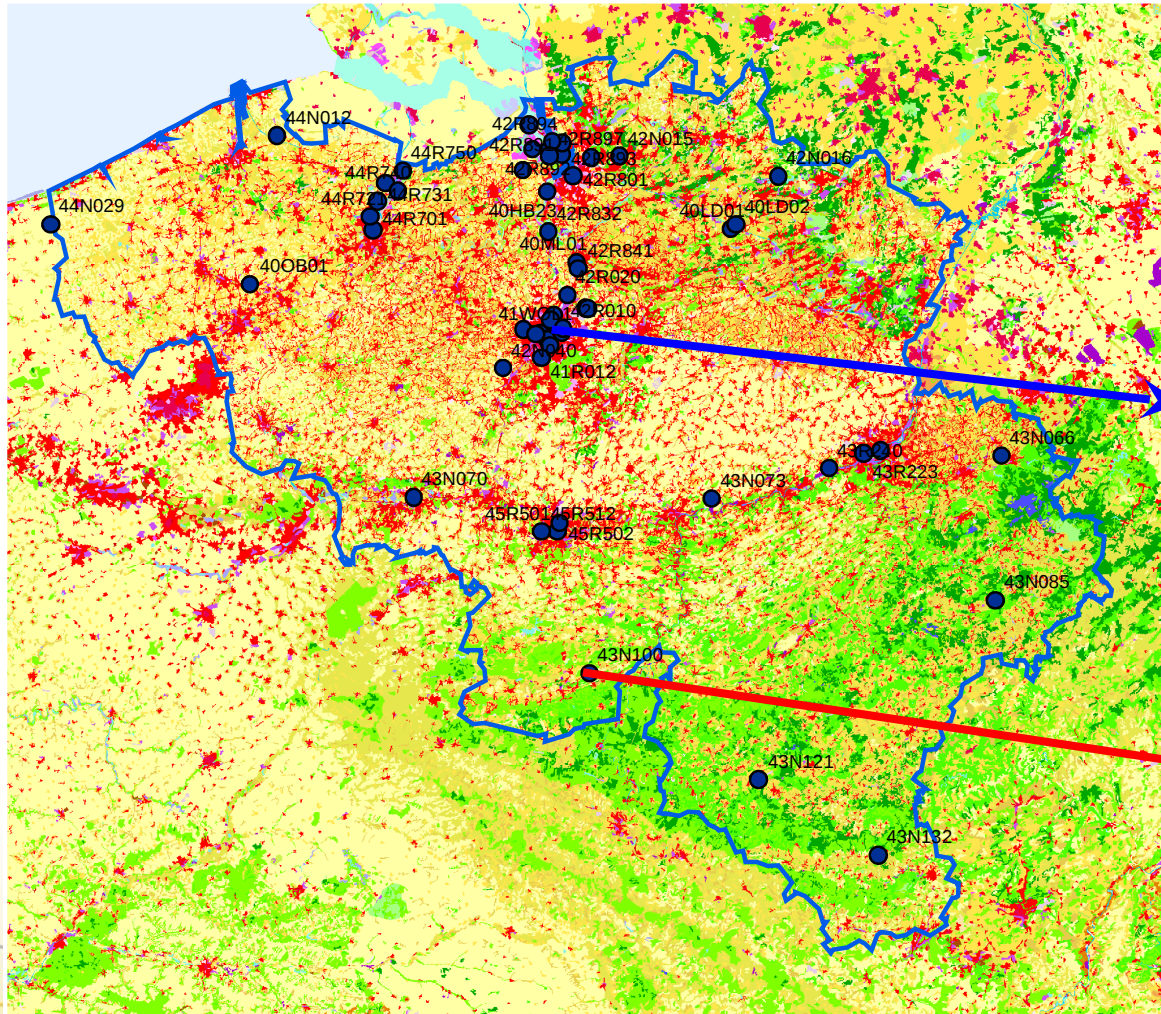


- Interpolation tools are only applicable for a **limited set of tasks** (assessments, mapping,...)
- Advantages of an (intelligent) **interpolation model**:
  - Fast (near real-time)
  - Accurate
  - Simple





# Introduction



# RIO-model: Methodology

- Observation:
  - Sampling values **depend on land use** in (direct) vicinity of the monitoring site
- Consequence:
  - Interpolation scheme needs to **know this relation** between land use and air quality levels
- Approach in RIO-model:
  - Create **land use indicator** to express this relation

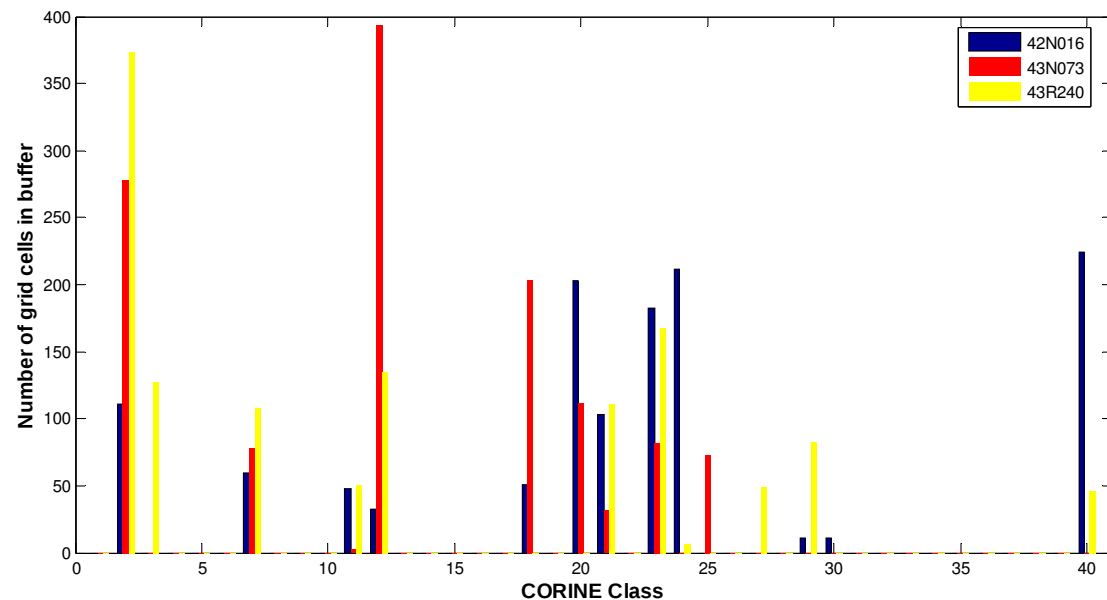
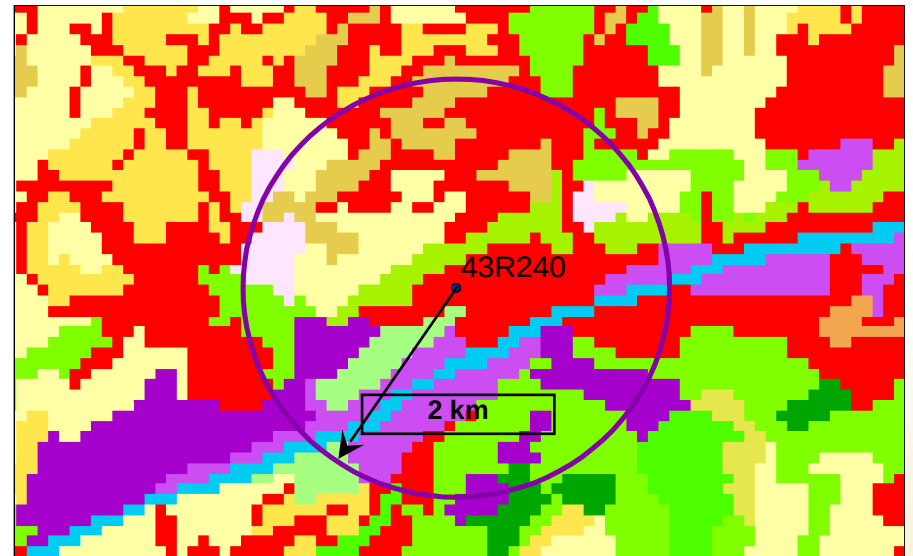


# RIO-model: Land use indicator

## Land use indicator

For each station:

- Determine buffer (e.g. 2km radius)
- Characterize land use by CORINE class distribution inside buffer





# RIO-model: Land use indicator

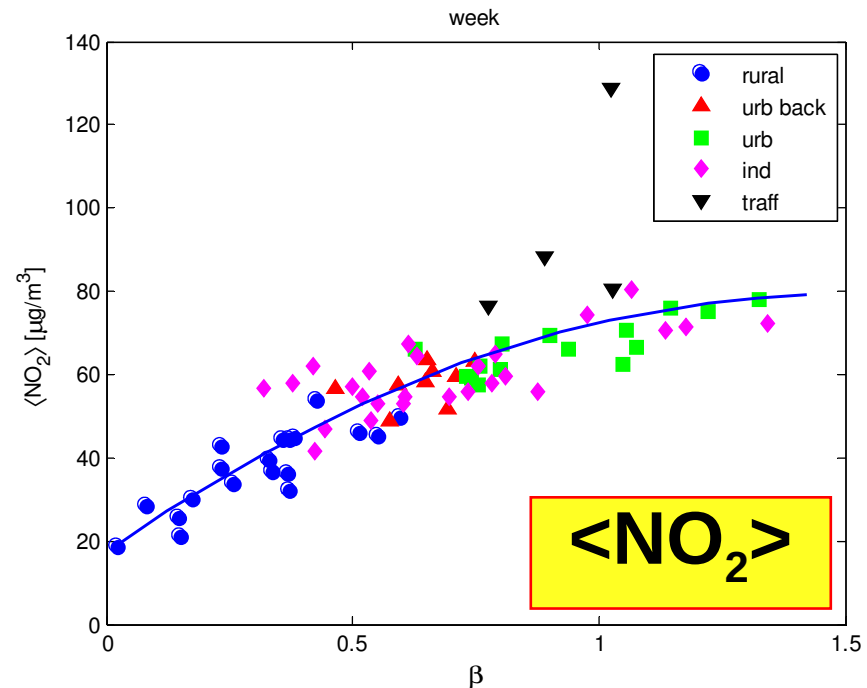
## RIO-model

- **Land use indicator** is based on CORINE class distribution

$$\beta_{\text{CORINE}} = \log \left[ 1 + \frac{\sum_i (a_i \cdot n_{\text{CORINE class } i})}{\sum_i n_{\text{CORINE class } i}} \right]$$

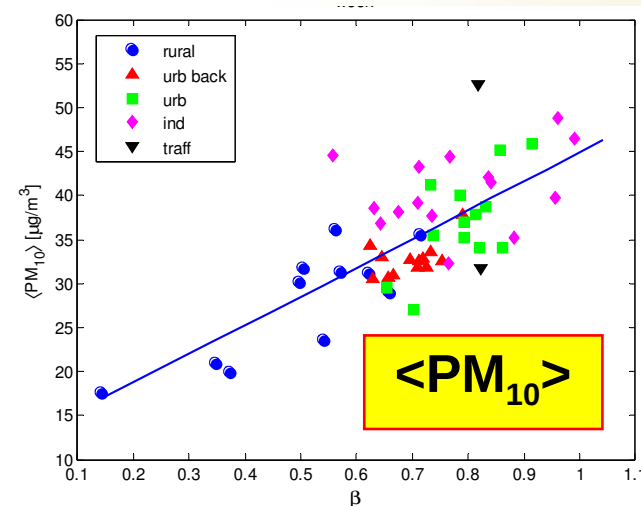
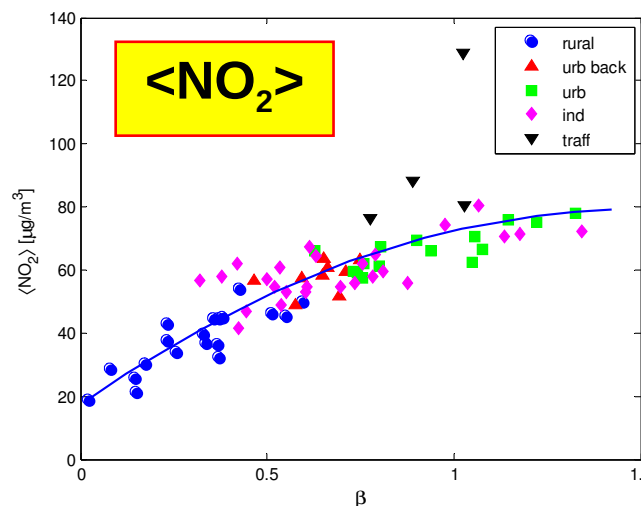
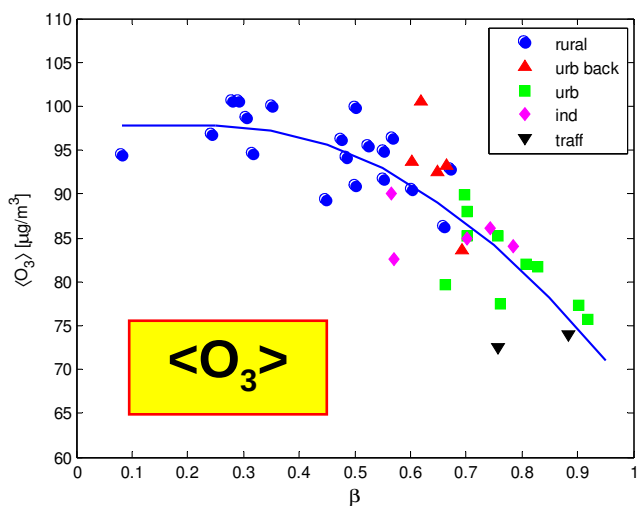
- **Calibration** of coefficients  $a_i$ :

multi-regression to optimize trend for mean and standard dev. of monitoring data



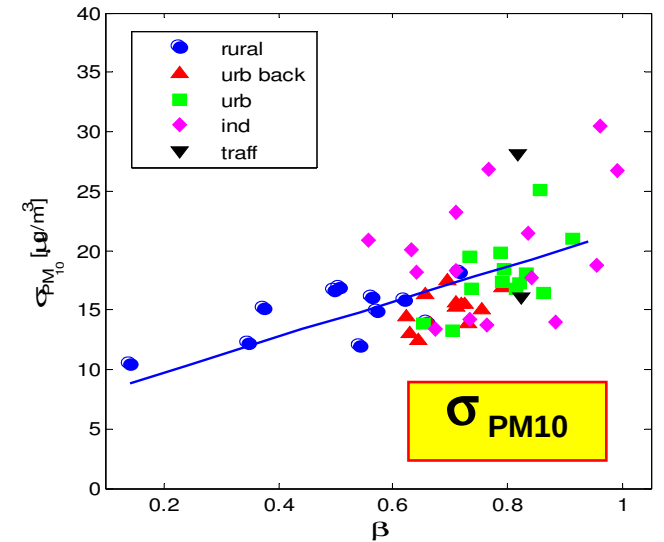
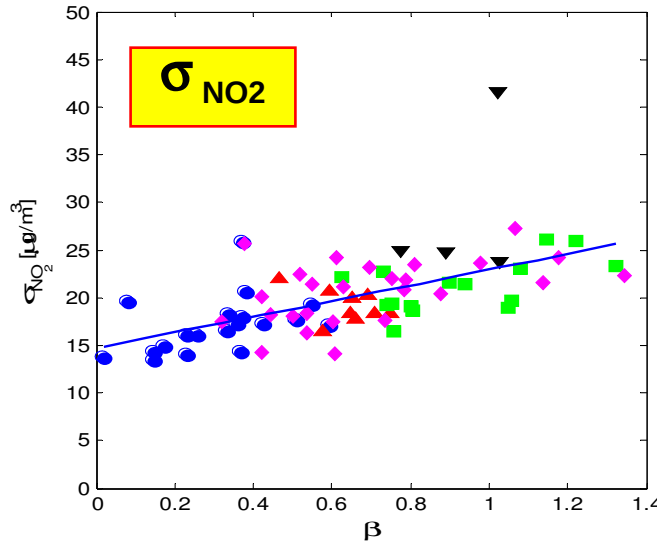
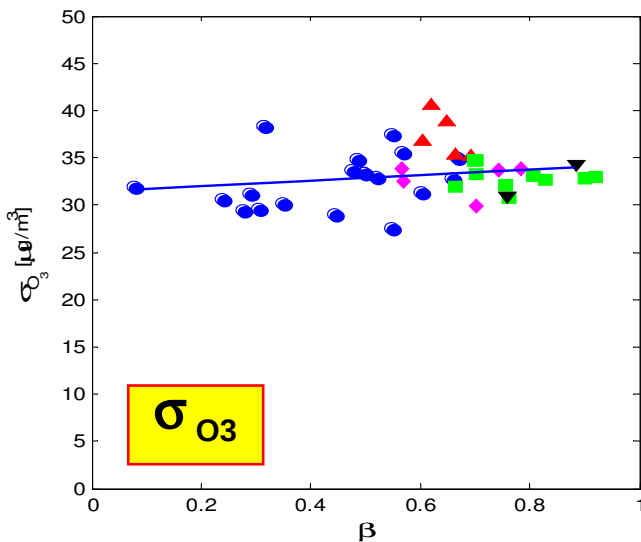
# RIO-model: Trend functions

- Trends in long term **mean** of sampling values:
  - Relation between land use and average air quality levels
  - **Smooth transition** between rural and urban sites



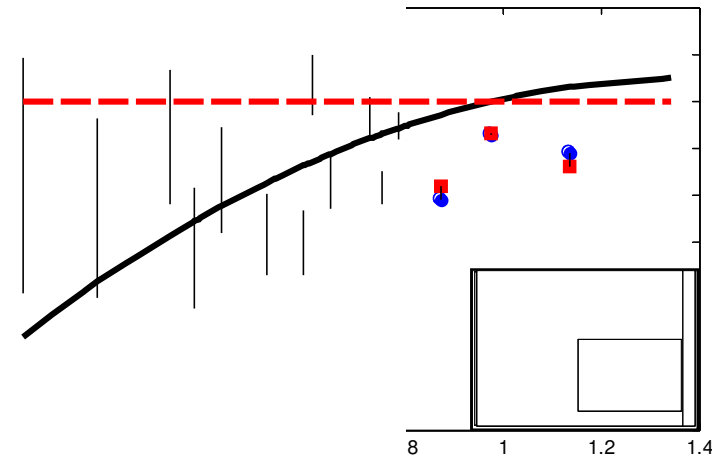
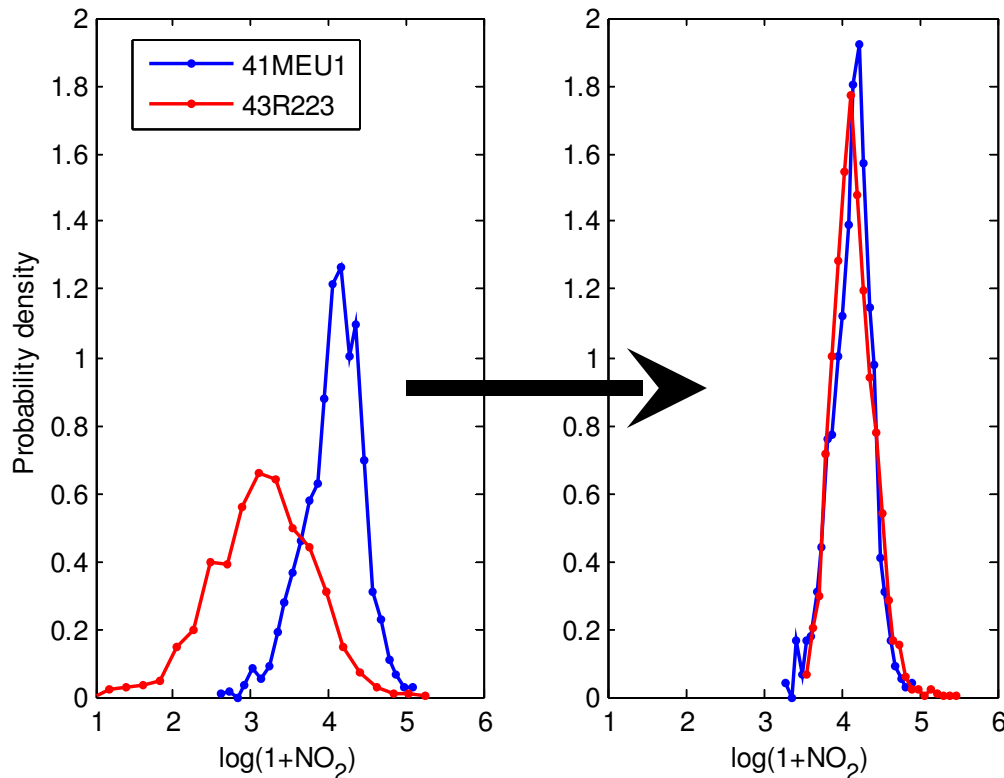
# RIO-model: Trend functions

- Trends also observed in **standard deviation** of sampling values:



# RIO-model: Detrending

- Use relation between land use indicator and AQ statistics to “detrend” monitoring data:
  - Remove **local character** of sampling values

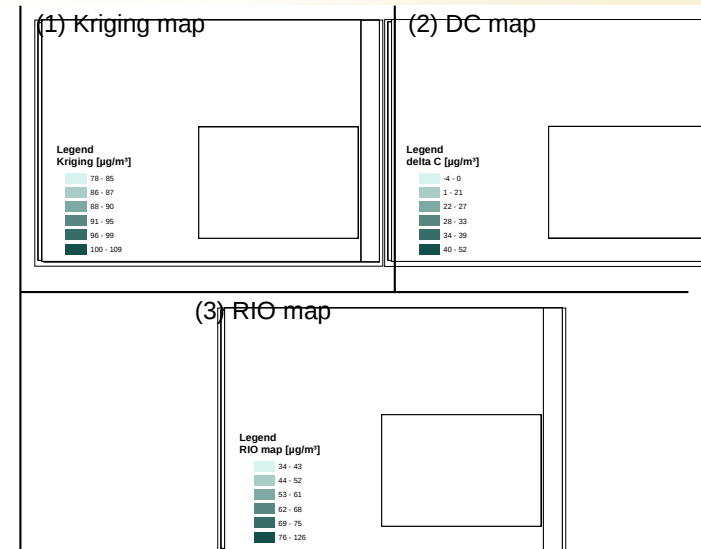
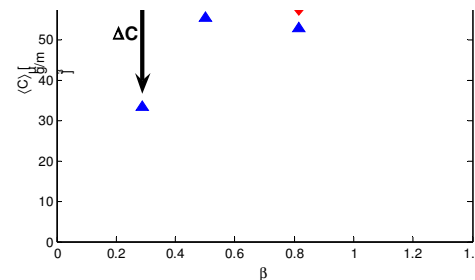
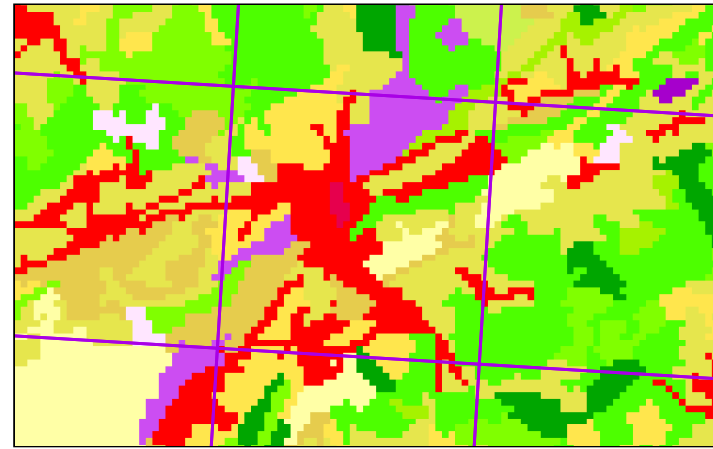




# RIO-model: Methodology

## RIO methodology:

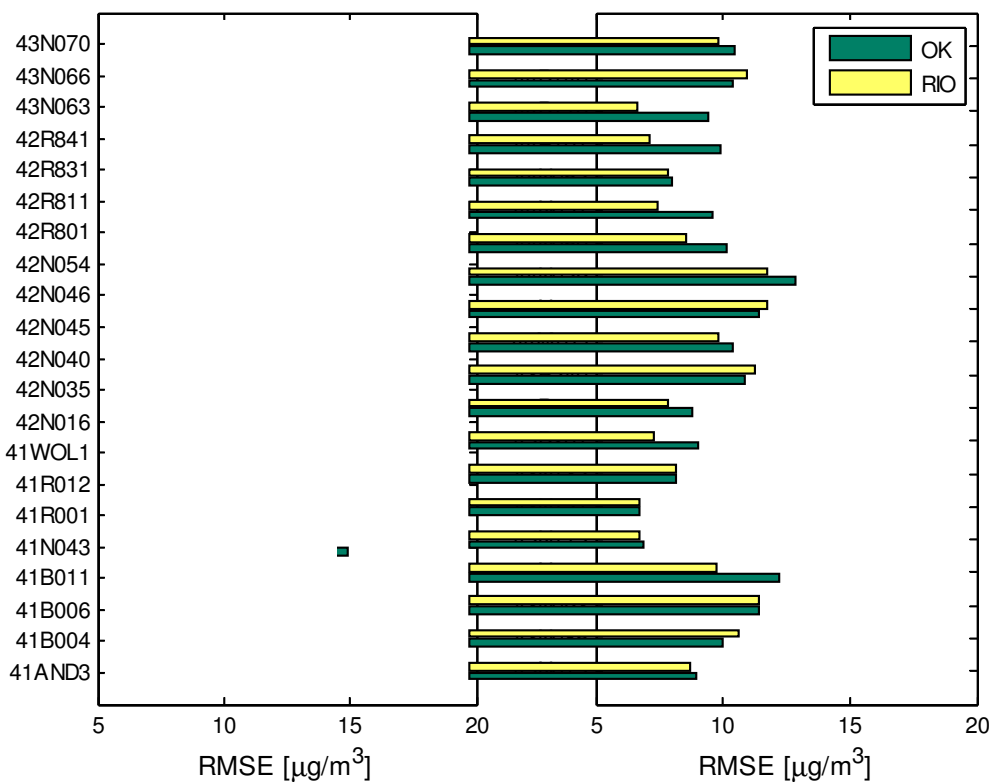
- Detrend sampling values
- Interpolate detrended values with Ordinary Kriging
- Determine local  $\beta$ -value
- Get corresponding trend shift ( $\Delta C$ )
- Add  $\Delta C$  to interpolation result



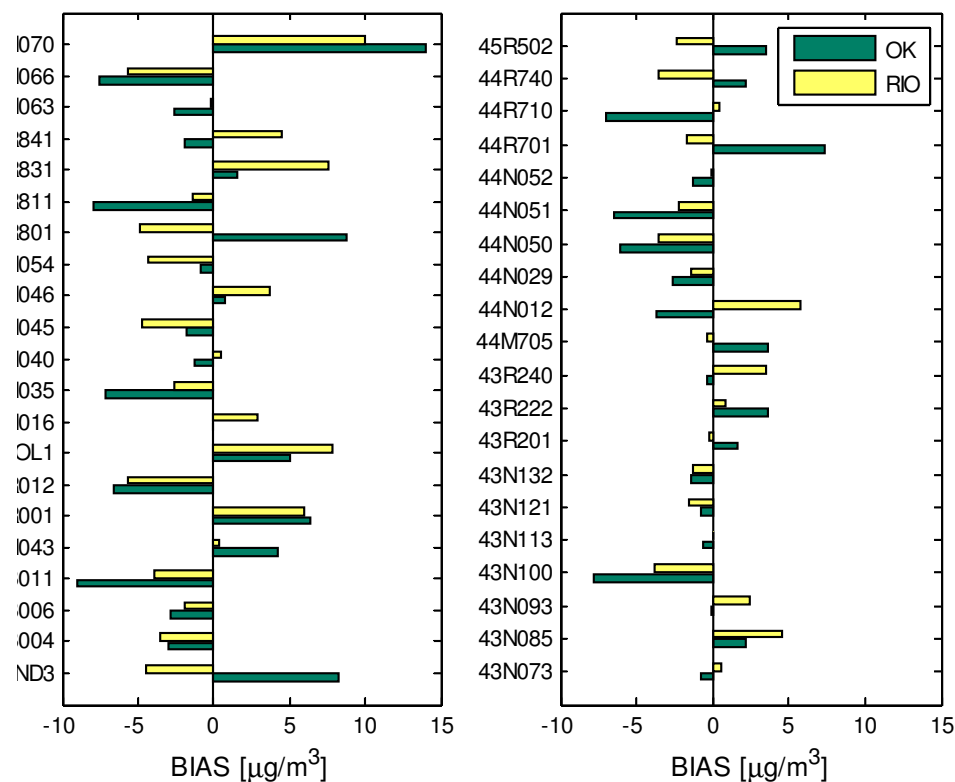
# RIO-model: Validation

Validation: leaving-one-out. Compare with standard OK

O<sub>3</sub> RMSE



O<sub>3</sub> BIAS



# RIO-model: Validation

Validation: leaving-one-out. Compare with standard IDW and OK

Model	O <sub>3</sub>		NO <sub>2</sub>		PM <sub>10</sub>	
	RMSE	Bias	RMSE	Bias	RMSE	Bias
IDW	10.97	-1.70	18.17	4.74	12.12	1.70
OK	10.37	-0.44	16.85	1.45	11.65	1.22
RIO	9.56	-0.08	14.45	-0.67	9.89	0.01



# RIO: Near real-time application

Home English Java - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.irceline.be/~celinair/english/homeen\_java.html

## IRCEL-CELINE

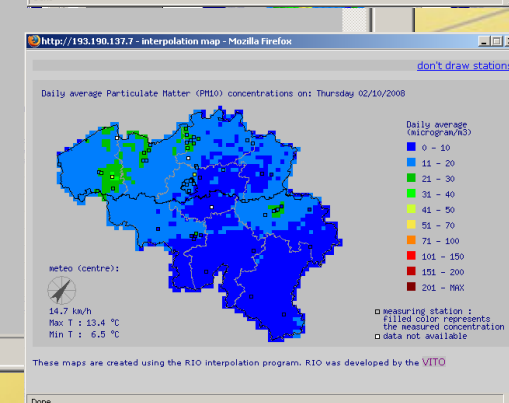
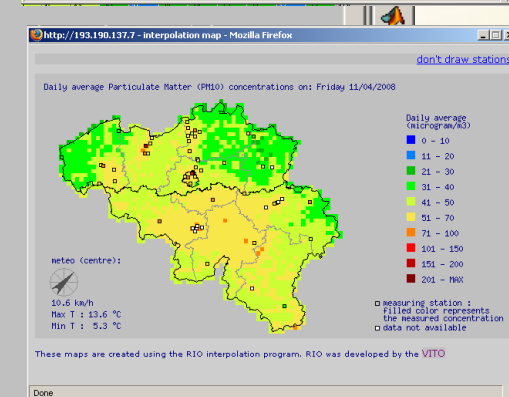
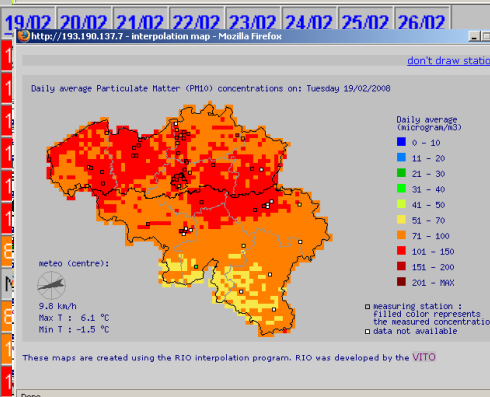
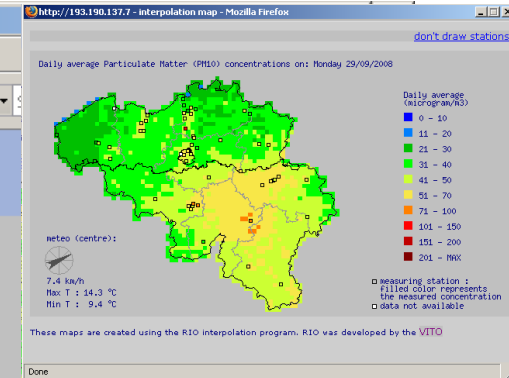
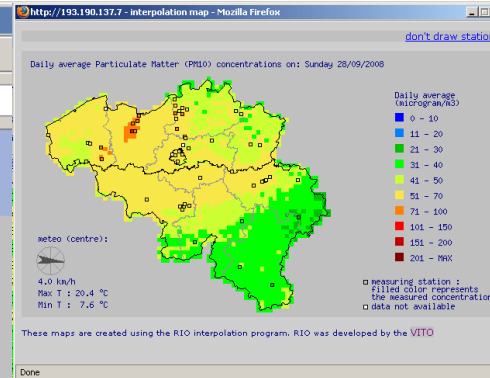
Informing you on ambient air quality in the Belgian Regions

previous 15 days

**Daily mean PM10 concentrations, 12/02/2008 - 26/02/2008**

info :  
-click on the figures in the table cells to get an evolution graph of daily concentrations

code	station	12/02	13/02	14/02	15/02	16/02	17/02	18/02	19/02	20/02	21/02	22/02	23/02	24/02	25/02	26/02
41B011	Sint-Agatha-Berchem	42	69	59	36	26	42	80	103	110	99	110	103	99	110	103
41MEU1	Neder-Over-Heembeek	51	68	58	38	29	50	93	121	130	88	35	51	54	34	52
41ND43	Haren	91	78	57	44	23	59	135	102	114	37	17	22	26	25	20
41R001	Sint-Jans-Molenbeek	70	73	62	42	30	59	105	102	114	37	17	22	26	25	20
41R012	Ukkel	27	54	50	31	21	32	58	104	83	65	17	32	25	24	20
41WOL1	Sint-Lambrechts-Woluwe	40	59	57	33	24	36	69	93	70	51	27	34	27	20	25
40AB01	Antwerpen (Boudewijnsluis)	42	54	34	26	27	47	81	104	143	74	27	35	35	32	26
40AB02	Berendrecht	32	39	27	20	23	46	NA	102	90	62	20	34	27	22	21
40ALD1	Antwerpen (LO)	42	59	34	23	21	47	96	104	83	65	17	32	25	24	20
40HB23	Hoboken	33	60	45	27	22	42	88	104	83	65	17	32	25	24	20
40MLD1	Mechelen (Hombeeksestwg)	NA	67	54	32	24	49	94	102	114	37	17	22	26	25	20
40MNO1	Menen	69	65	81	30	30	45	103	99	110	99	110	103	99	110	103
40OB01	Oostrozebeke	62	75	84	41	36	49	104	121	130	88	35	51	54	34	52
40RLD1	Roeselare (Brugsesteenweg)	61	69	78	37	28	49	93	102	114	37	17	22	26	25	20
40SZD2	Steenokkerzeel	38	58	53	29	21	37	63	104	83	65	17	32	25	24	20
40WZD1	Lommel	34	53	36	20	20	26	59	93	70	51	27	34	27	20	25
42M802	Antwerpen (Luchtbal)	42	61	44	28	24	60	100	104	143	74	27	35	35	32	26
42ND16	Dessel	29	59	44	24	20	30	63	102	90	62	20	34	27	22	21
42ND35	Aarschot	NA	NA	60	36	26	34	66	135	86	68	13	26	26	22	18
42ND45	Hasselt	39	82	88	32	21	45	101	141	80	67	23	29	34	24	21
42ND54	Walshoutem	41	54	69	30	23	31	56	132	60	66	24	25	31	22	19

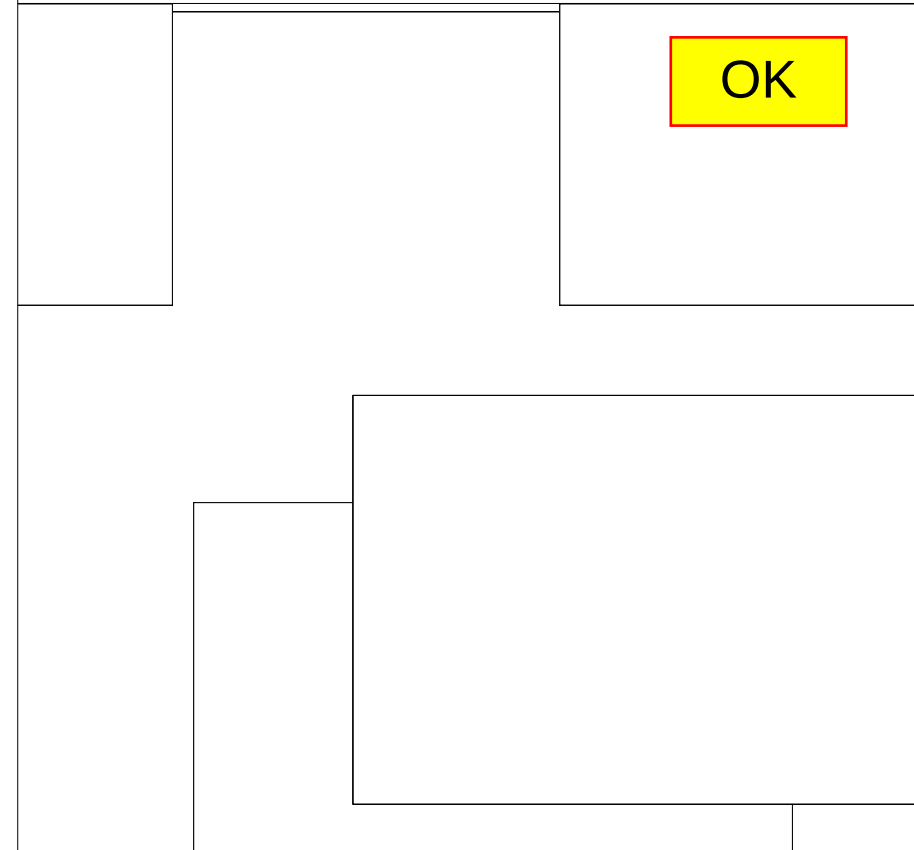
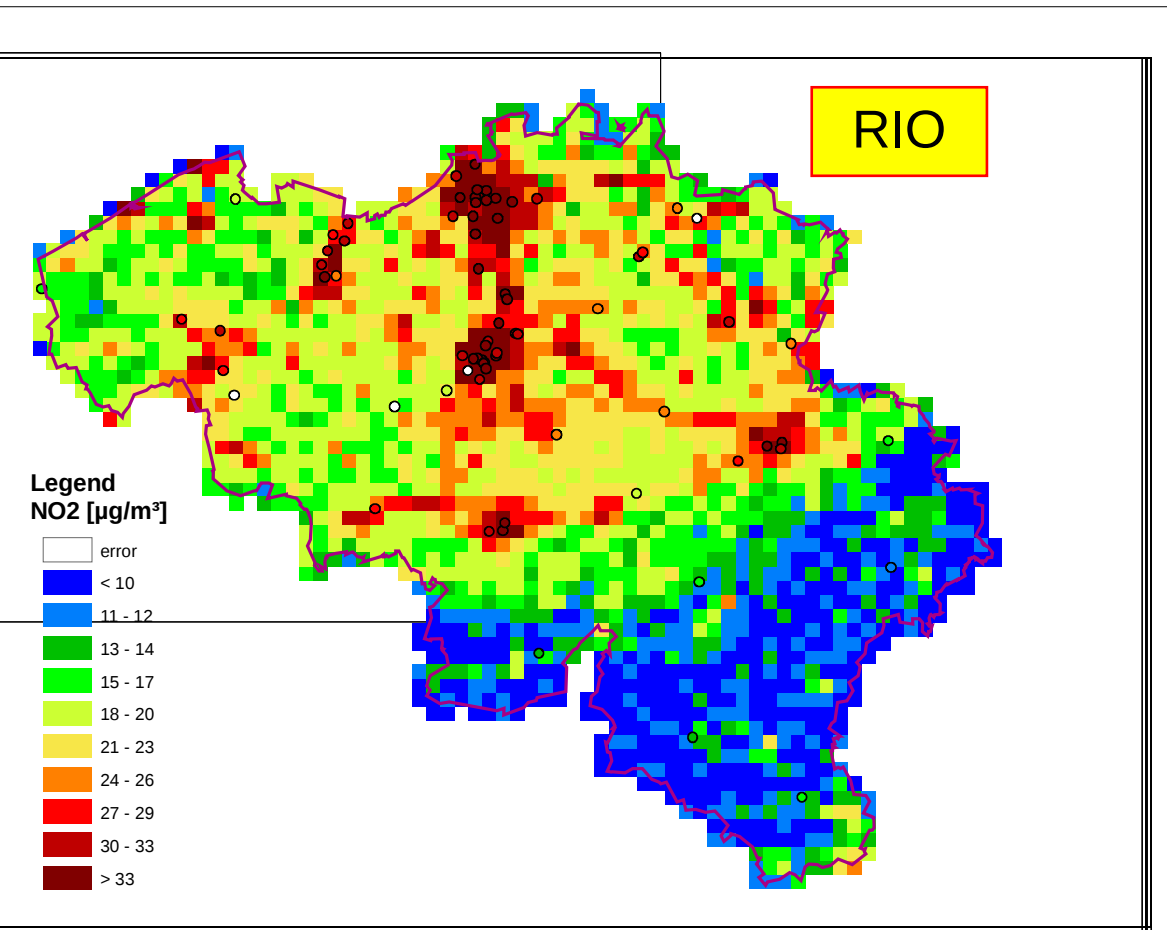


Done



# RIO: Annual averages

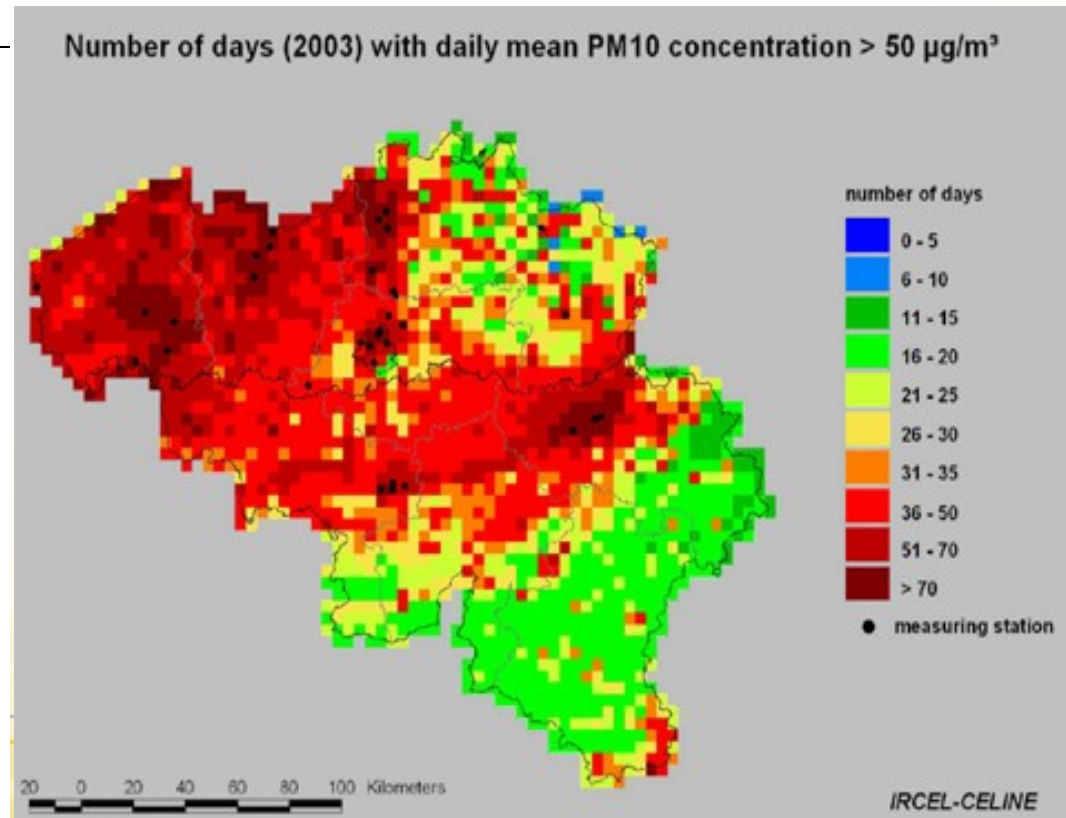
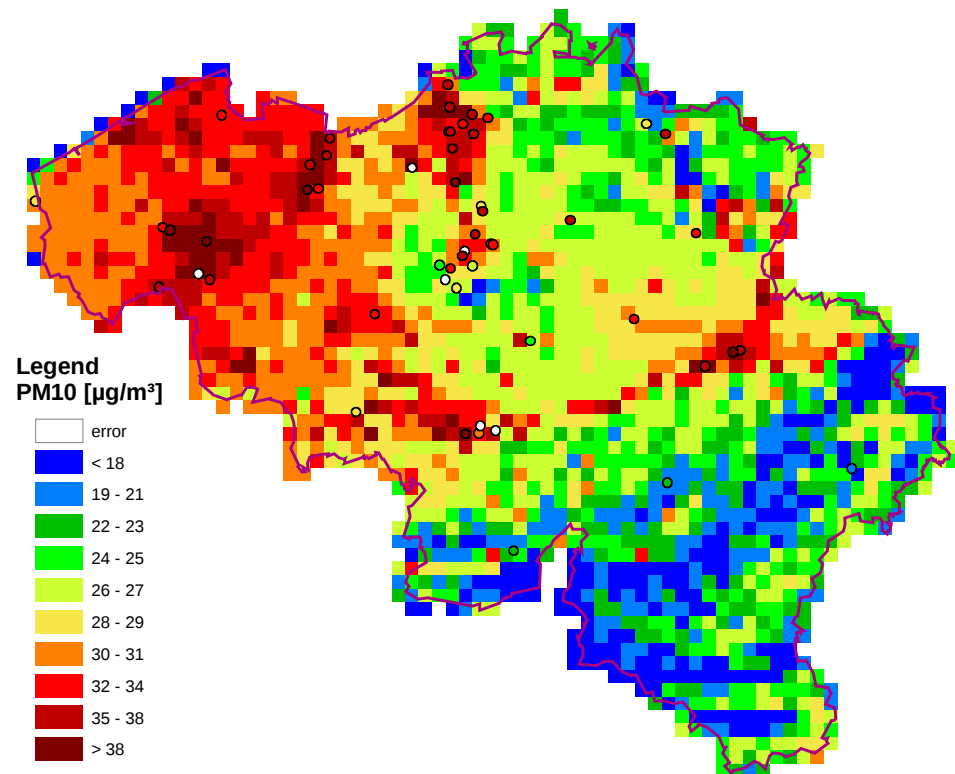
## Annual average NO<sub>2</sub> concentrations for 2006



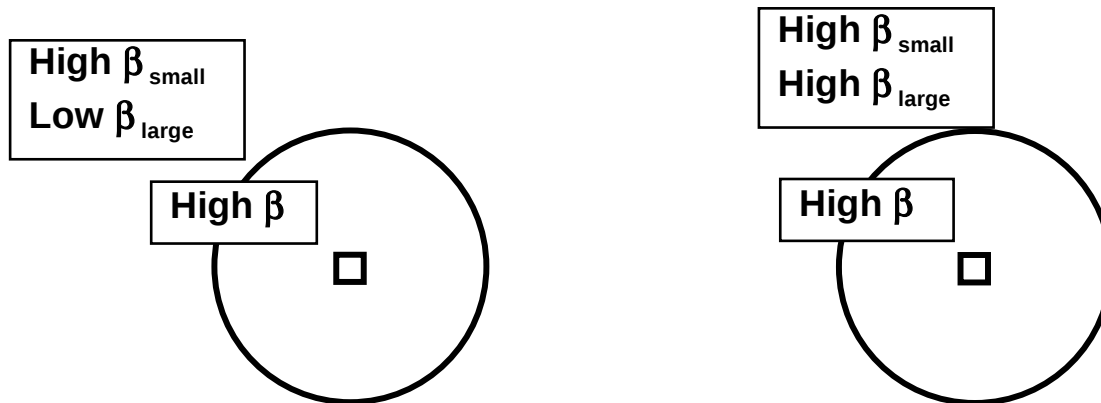
# RIO: Annual averages

Annual averaged PM<sub>10</sub> concentrations for 2006

Number of days exceeding the 50 µg/m<sup>3</sup> daily PM<sub>10</sub> limit in 2003

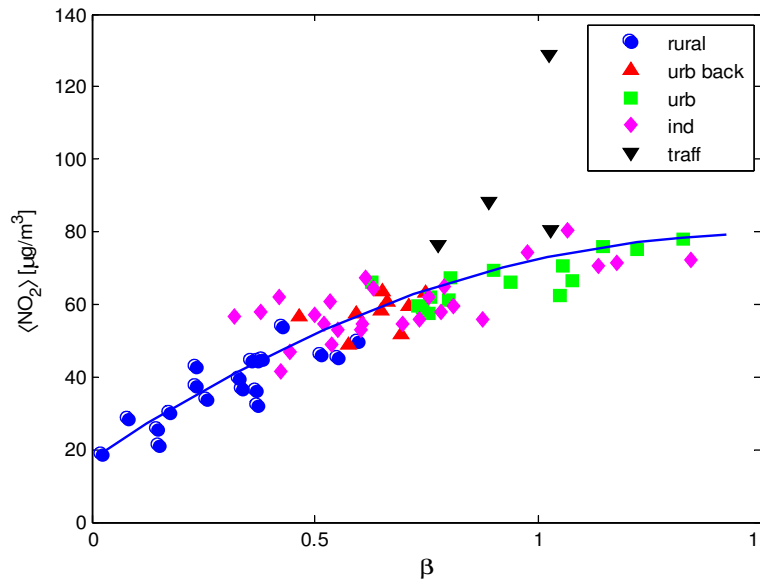


# RIO: New developments

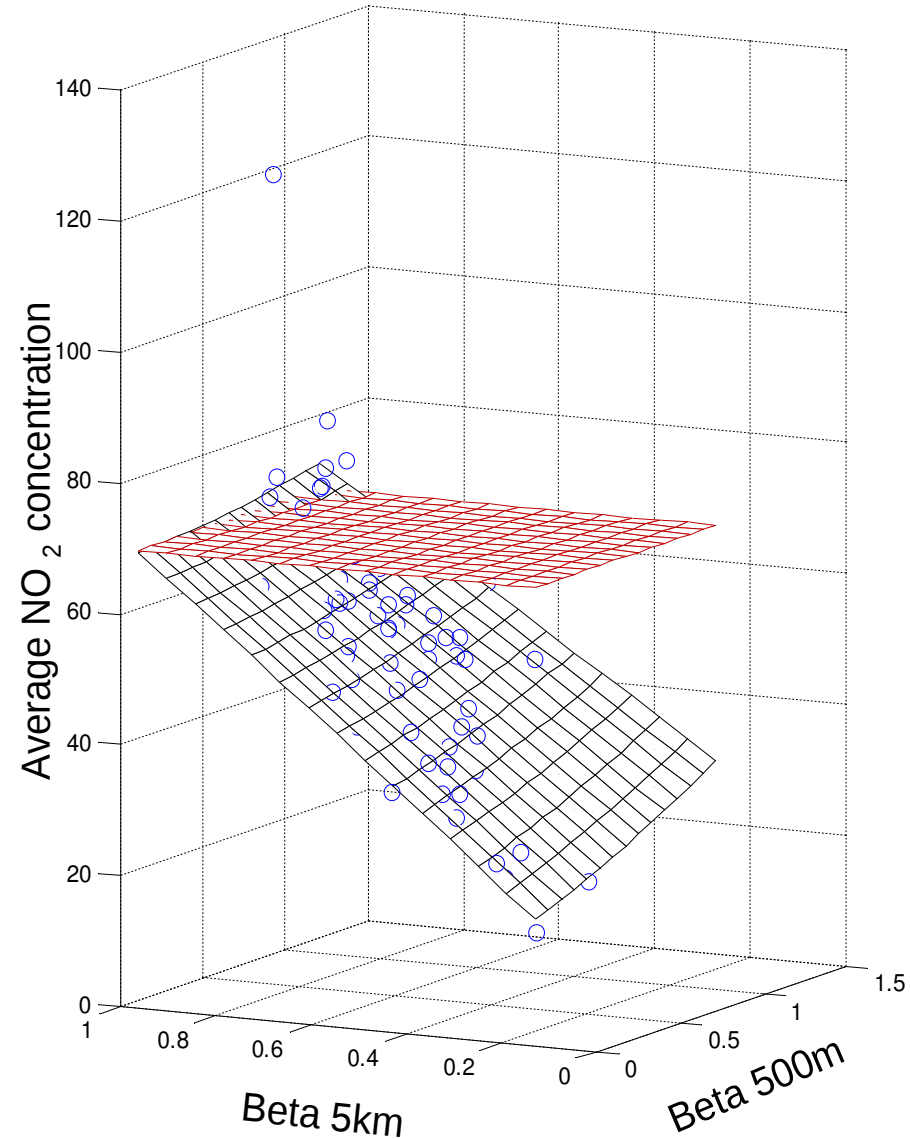


# RIO: New developments

- Double scale in  $\beta$  parameter
  - Combined land use information at 1km and 10km spatial scale

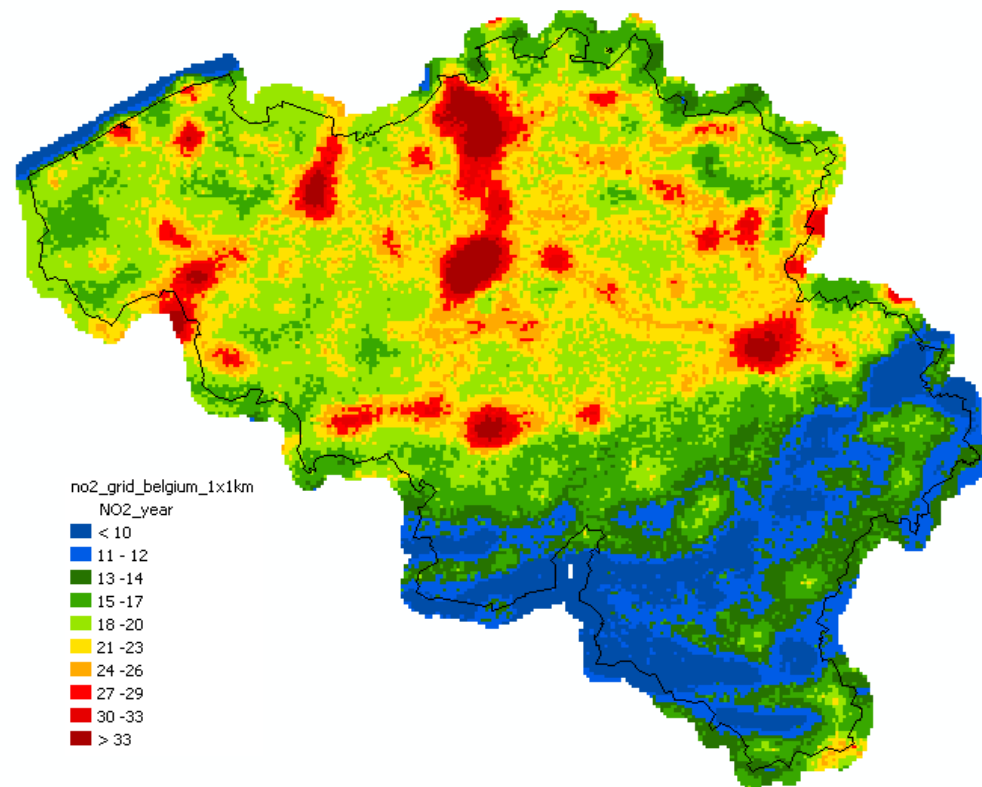
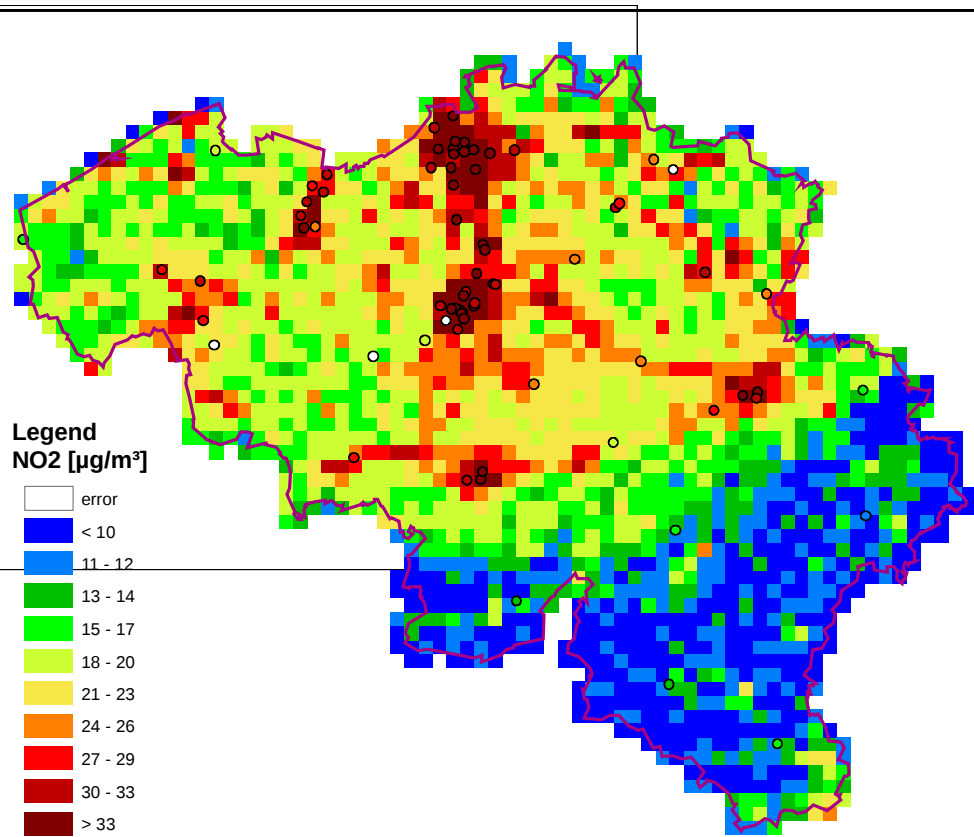


1D  $\longrightarrow$  2D





# RIO: New developments



# Conclusion

- RIO is an operational **interpolation scheme** for ambient air pollution ( $O_3$ ,  $NO_2$ ,  $PM_{10}$ , ...)
- **Kriging** is used as interpolation tool
- A land use model is applied to incorporate **local patterns**
- Detrending is an **essential step** for the interpolation of air quality values
- Intelligent interpolation models can be applied as **accurate, efficient** and **fast** assessment tools

