



Validation of a geostatistic method

Measurement campaign vs. interpolation method

1 – Goal

Aim : to validate a mathematical interpolation model (Geostatistic approach : Kriging) by a measurement campaign.

A telemetric network, consisting of **fixed measurement stations** (■) is used to control the quality of the air.

→ 14 fixed stations in Wallonia continuously measure the particles concentrations (PM10* and PM2.5*) in the air with a laser diffraction technology, and integrate every 30 minutes.

Based on these fixed stations data, the geostatistic interpolation model is applied to estimate the concentrations all over Wallonia.

3 – Geostatistic method

In the geostatistic approach, what differs from a statistics approach is that the spatial auto-correlation between two neighbouring values is taken into account.

Variogram

The aim of the variogram is to weight the measures according to the distance between two stations locations.

- First an experimental variogram is computed. Variogram of the variable z :

$$\gamma(h) = \frac{1}{2N_h} \sum_{i=1}^{N_h} (z(x_i) - z(x_i + h))^2$$
 h : distance between the two stations i and j
 N_h : number of pairs of stations spaced of a given distance h
- Then a theoretical variogram is modeled using defined types (linear, spherical, etc.) to be the closest to the experimental one. In our case, the linear type is chosen.
- Finally the variance of the error is minimized
 $m_z = E[z]$: Expectation
 $\sigma_z^2 = E[(z_i - m_z)^2]$: Variance

2 – Methodology

A second network consisting of 6 additional **mobile measurement stations** (●) was installed during 3 months to measure the concentrations of particulate matter in 6 strategic locations.

Validation steps:

- Measurement of particulate matter concentrations at fixed stations of the telemetric network (■)
- Interpolation of these measures to estimate the concentration for the 6 strategic positions
- Measurement of particulate matter concentrations on the 6 strategic positions by using the 6 mobile stations (●)
- Comparison of the interpolated values (2.) to the ones given by the mobile measurement stations (3.)
- Analysis of the error variance of the geostatistic method compared to results of point 4

4 – Measurement locations

Fixed telemetric network (■)

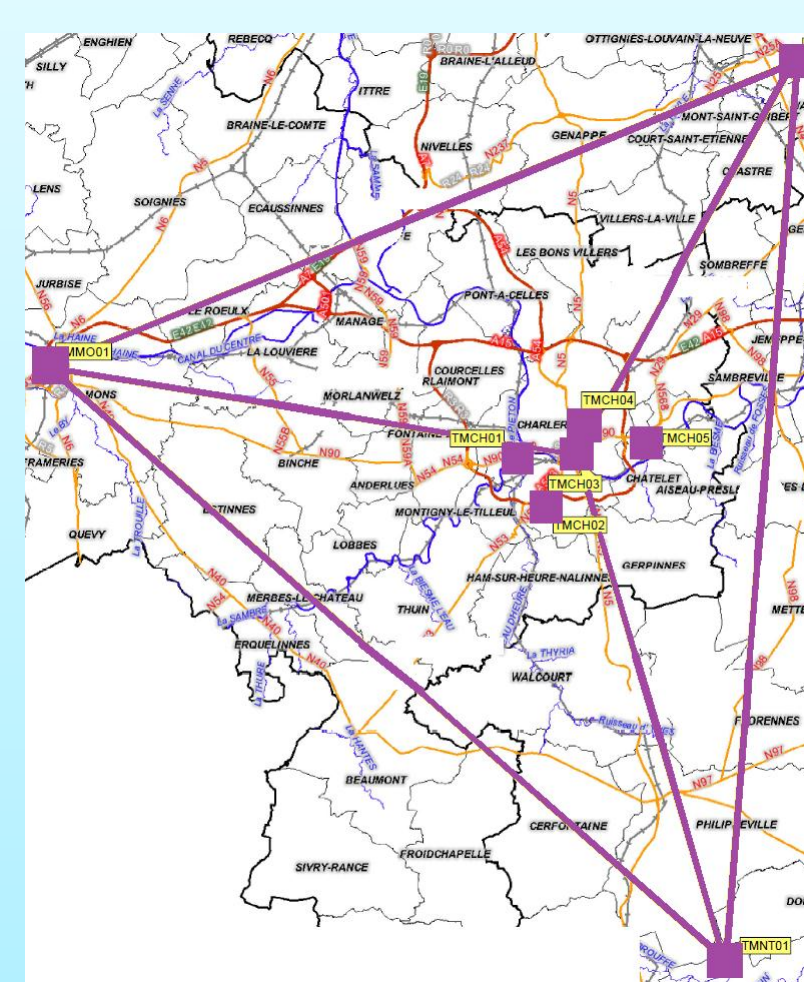


Figure 1a : Only fixed network

Mobile network (●)

The six **mobile stations** are installed where the **error of interpolation is maximal** ($5 \mu\text{g}/\text{m}^3$), i.e. halfway to fixed stations

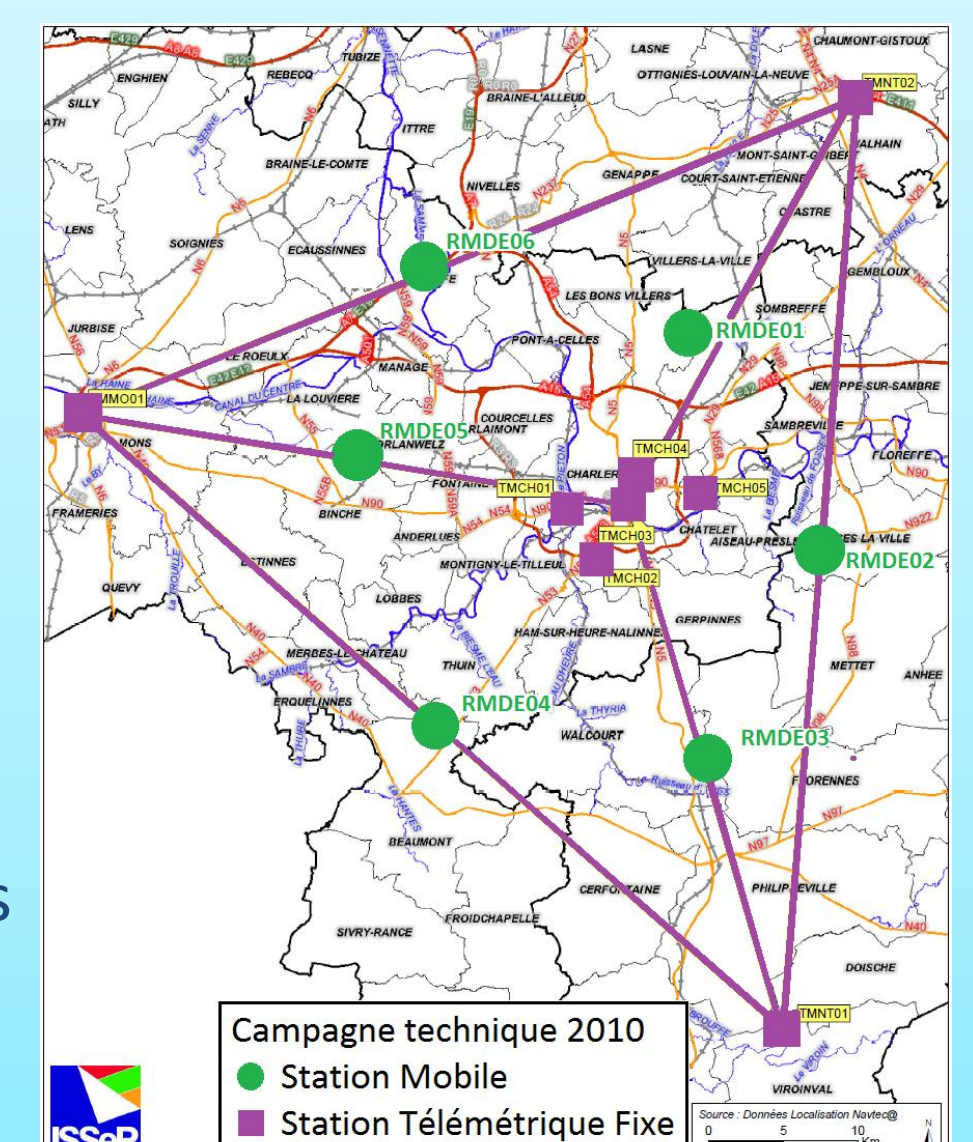


Figure 1b : Locations of the fixed and mobile stations around Charleroi

5 – Results

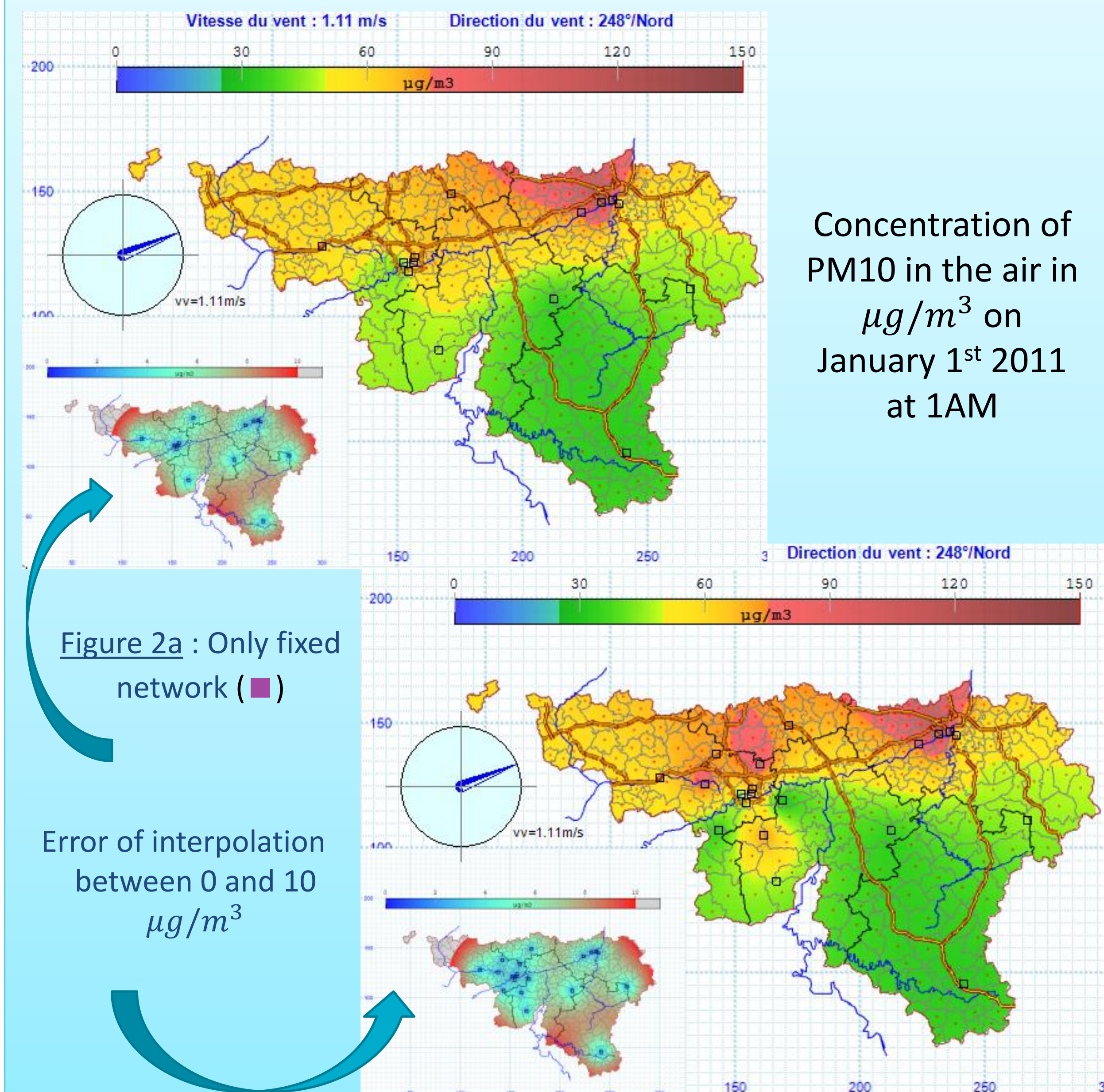


Figure 2a : Only fixed network (■)

Figure 2b : Both fixed (■) and mobile networks (●)

6 – Comparisons

Comparisons between interpolated and measured concentrations of PM10 in the air in $\mu\text{g}/\text{m}^3$ in Morlanwelz

- Measurement at mobile station (3.)
- Interpolation of data given by the fixed stations (2.)
- Interpolation \pm confidence interval (CI = 99%)

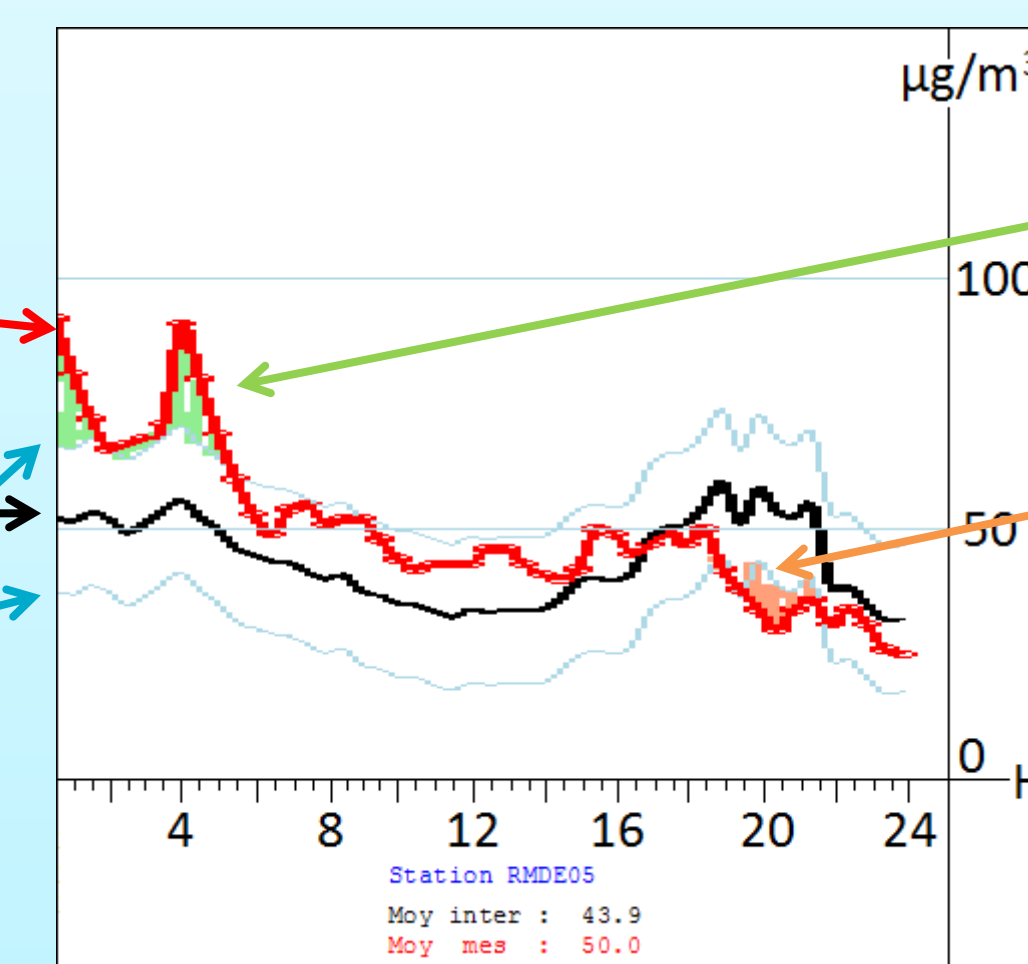


Figure 3 : Half-hourly measurements on January 1st 2011

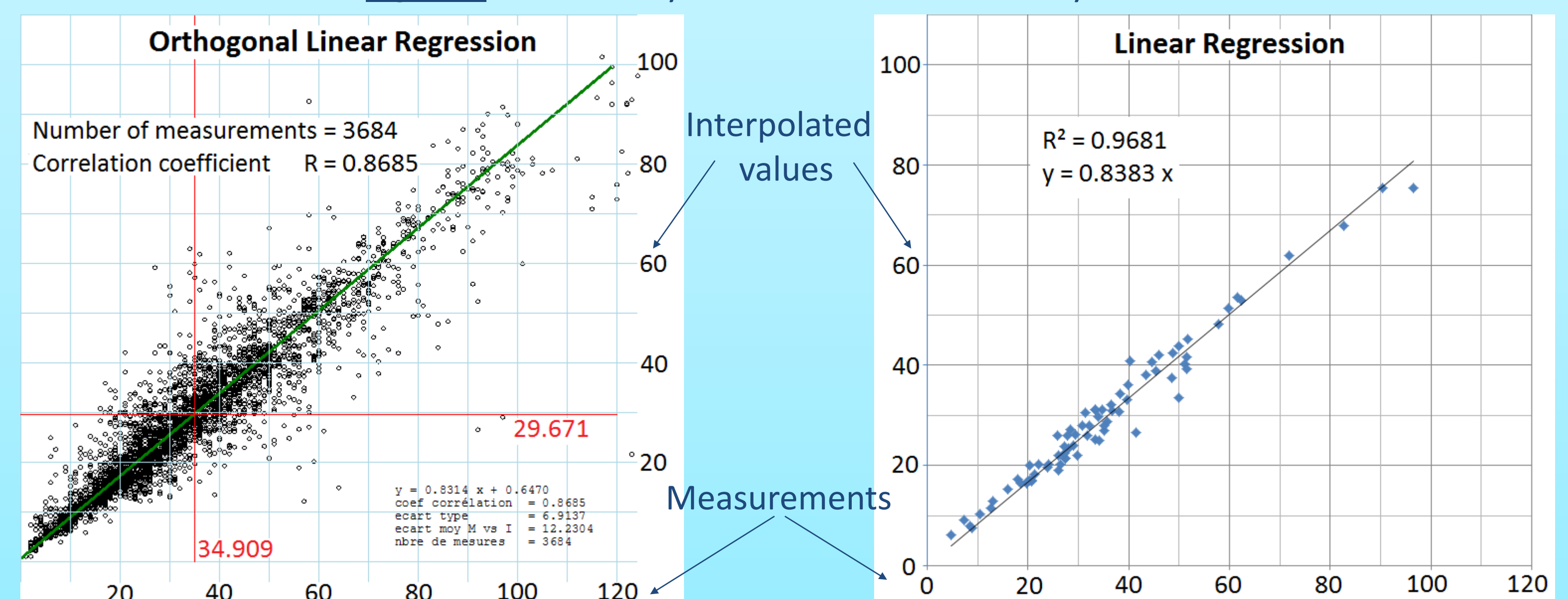


Figure 4 : Half-hourly measurements

Figure 5 : Daily means

Comparison period from November 16th 2010 to January 31st 2011

7 – Conclusions

- Geostatistic model **successfully** validated by orthogonal linear regression : correlation coefficient ≈ 1
- 3 reasons to compare results on daily averages :
 - Working with half-hourly measurement includes spots
 - European regulations about air quality given for daily averages
 - As the transport and diffusion phenomena have a certain duration, the longer the period of comparison, the better the correlation

8 – Comments

Stations location

- 5 stations in Charleroi center giving almost the same measurements → some of them could be moved to more strategic places
- Mobile stations show local phenomena which are not noticed with the fixed stations → necessity to add fixed measurement stations

Discussions

- Concentrations in Charleroi centre lower than the ones measured by the mobile stations → metrological issue
- The same comparisons could be done for gases such as NOx or O3 but to do this, measurements during summer are needed → new campaign?

Definitions

- *PM2.5: also named "fine particles", diameter $< 2.5 \mu\text{m}$
- *PM10: diameter $< 10 \mu\text{m}$

Partners

AWAC : Walloon air and climate agency
ISSEP : Scientific institute of public services

Website <http://airquality.issep.be>

