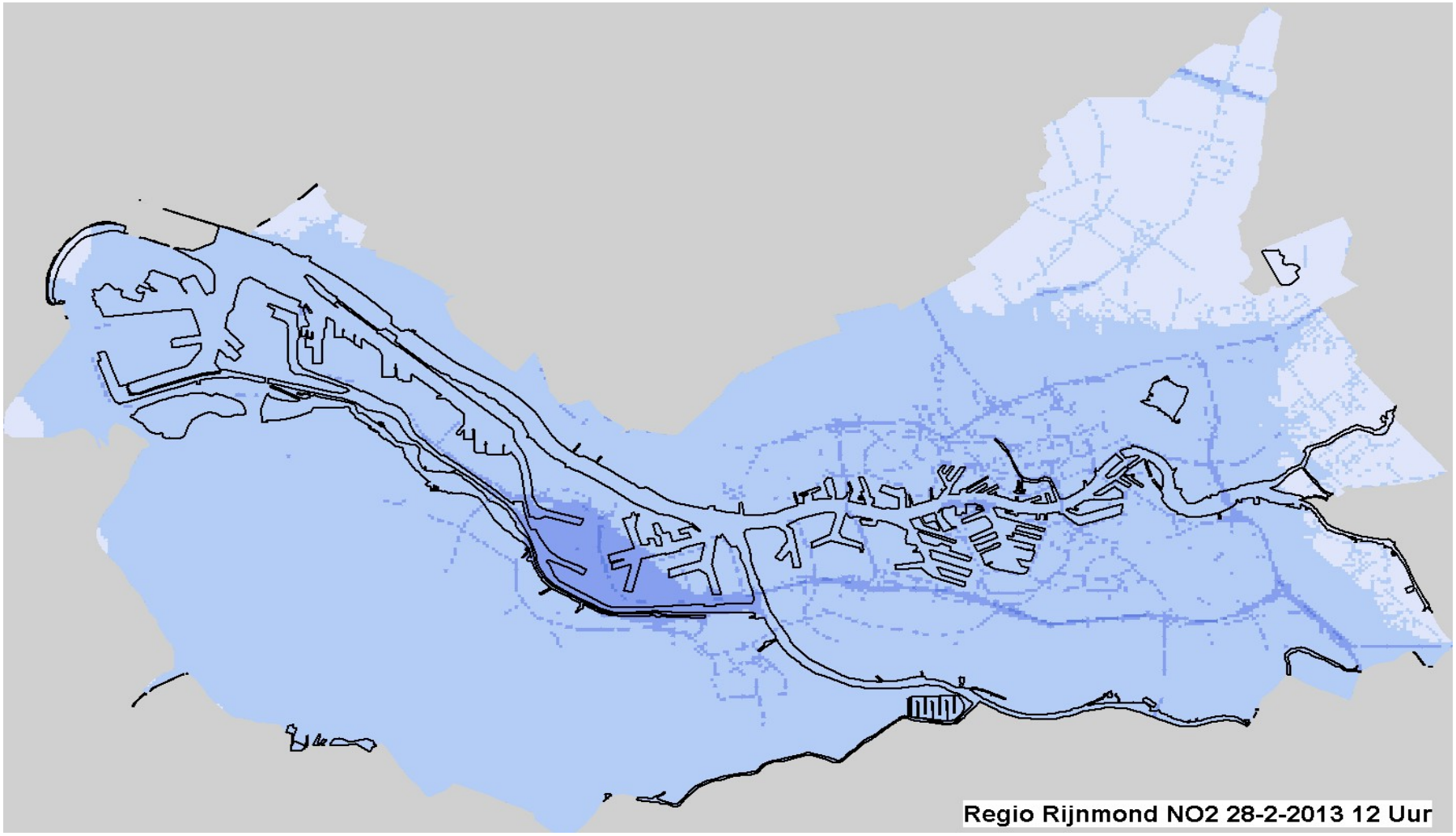
Jan Duyzer
Richard Kranenburg

Couple results of model calculations and measurements

TNO | Knowledge for business

On line results: of monitoring and model calculations URBIS Real Time



Goals

- Detailed maps of concentration using:
  - Measurements 11 stations
  - Dispersion models based upon detailed emissions
- Also demand:
  - Realistic (high quality)
  - On line

- Introduce:
  - URBIS
  - URBIS Real time
  - Improvements
  - Kalman Filtering

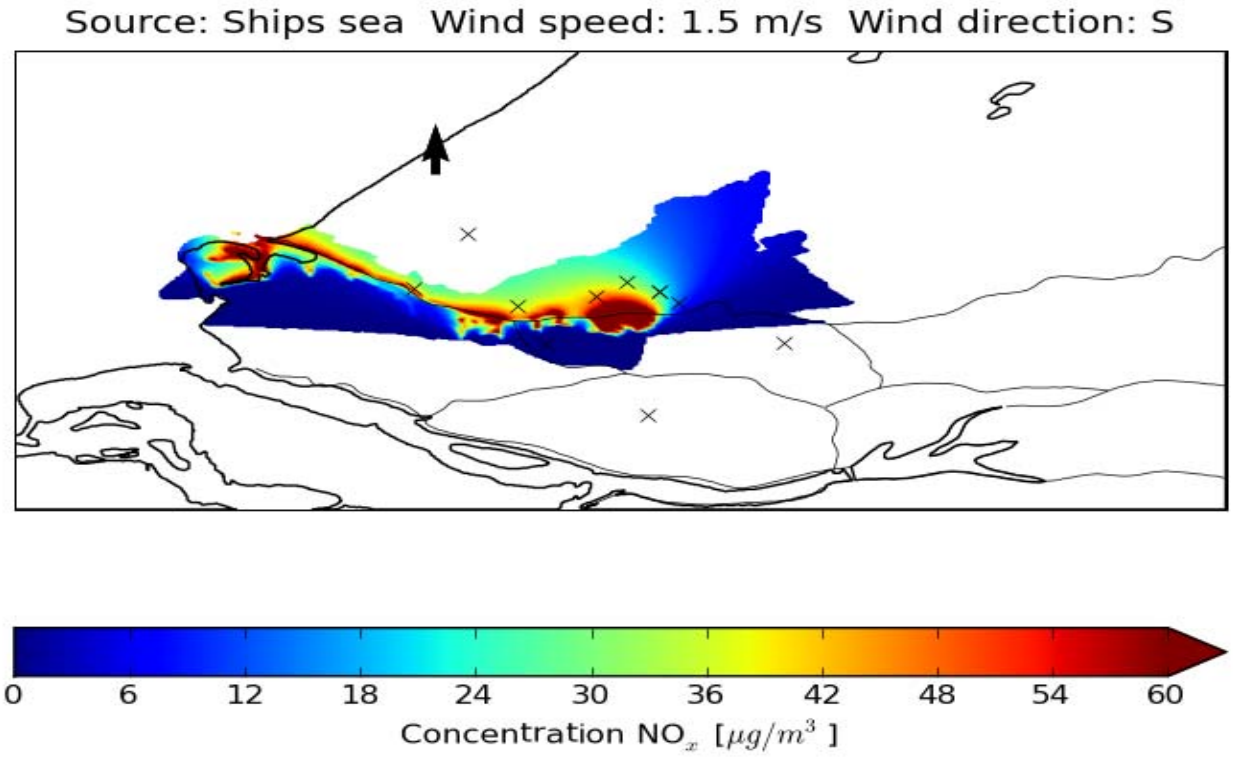
URBIS

- Gaussian plume models for
  - Point and area sources (industry, shipping, housing)
  - Roads
- Streets
  - CAR model
- Emissions based upon detailed inventory for the Rotterdam Area

Real Time URBIS Model for NOx

- Model calculates offline
  - Concentration in air in the area
  - Store calculations for
    - 11 source categories,
    - 4 wind directions
    - 2 wind speeds
- Interpolate on the basis of actual
  - Wind speed
  - Wind direction

One out of 88 stored concentration maps

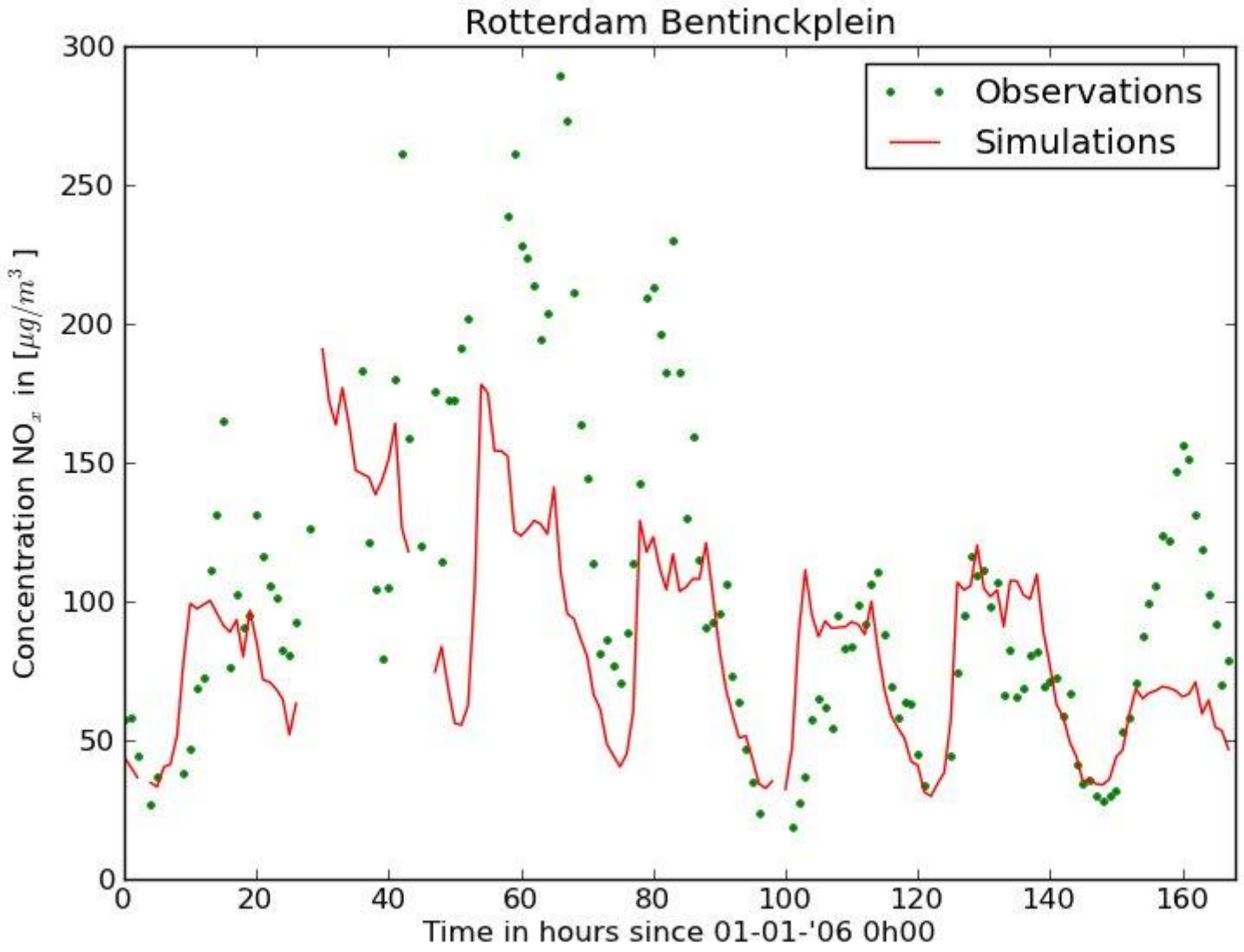


Real Time URBIS model

- Every hour interpolation using between standard concentration maps
- Correction for domestic and traffic fields

$$c_k^m = \sum_{i=1}^{88} \mu_{i,k} m_i$$

- Where:
  - μ is the weight function depending on
    - wind direction (φ), wind speed (v),
    - temperature (T)
    - hour (h), day (d), month (m)
  - standard concentration maps m_i

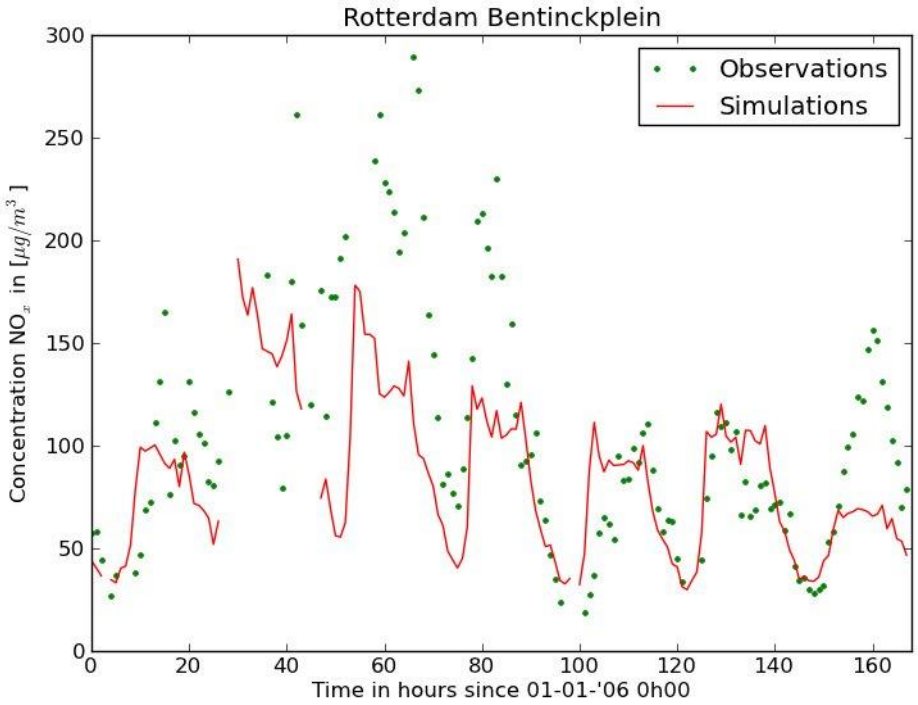

Rotterdam Bentinckplein
Observations
Simulations
Concentration NO_x in [$\mu g/m^3$]
Time in hours since 01-01-'06 0h00
0
50
100
150
200
250
300
0
20
40
60
80
100
120
140
160

Combine results of measurements and model calculations

- Assumption
  - Model results fro local contribution are correct
  - Background contribution one value for whole area
- Derive background concentration from measurements on three stations

$$C_{background} = C_{measured} - C_{calculated}$$

- Correct all values for background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Time in hours since 01-01-'06 0h00
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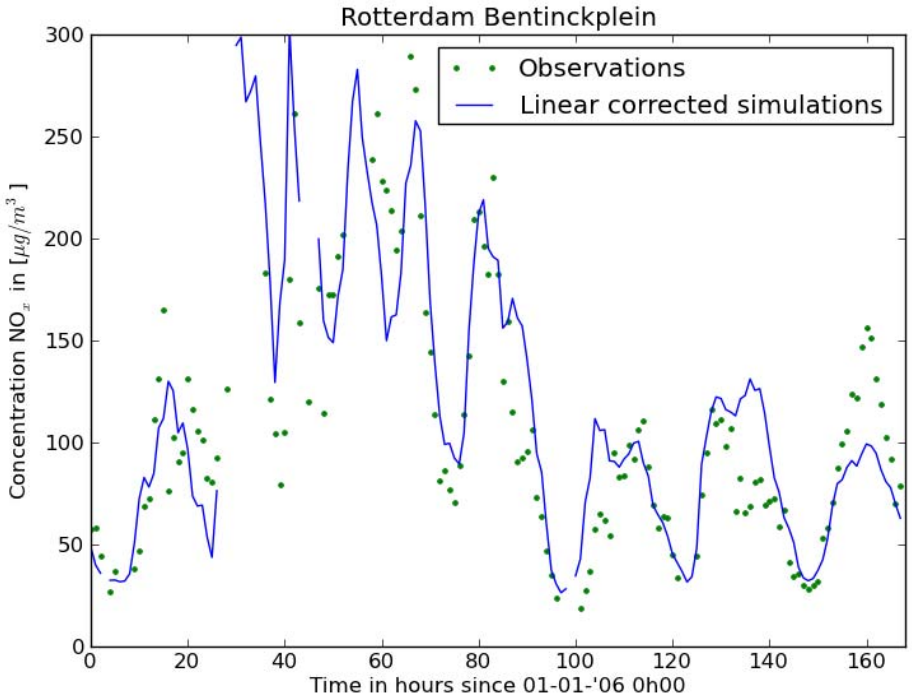
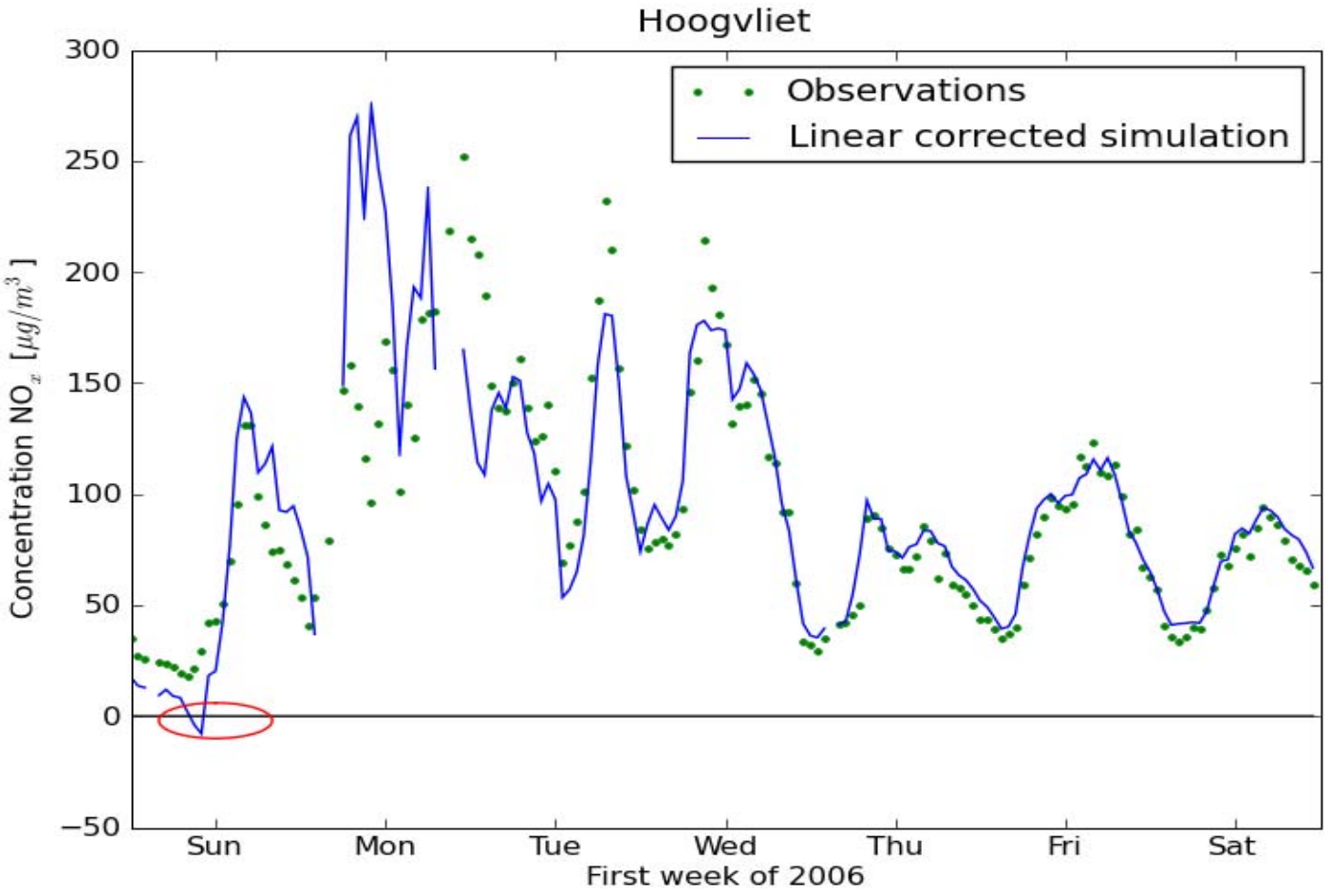
120
140
160


Rotterdam Bentinckplein
Observations
Linear corrected simulations
Concentration NO_x in $[\mu g/m^3]$
Time in hours since 01-01-'06 0h00
0
50
100
150
200
250
300
0
20
40
60
80
100
120
140
160

Other stations

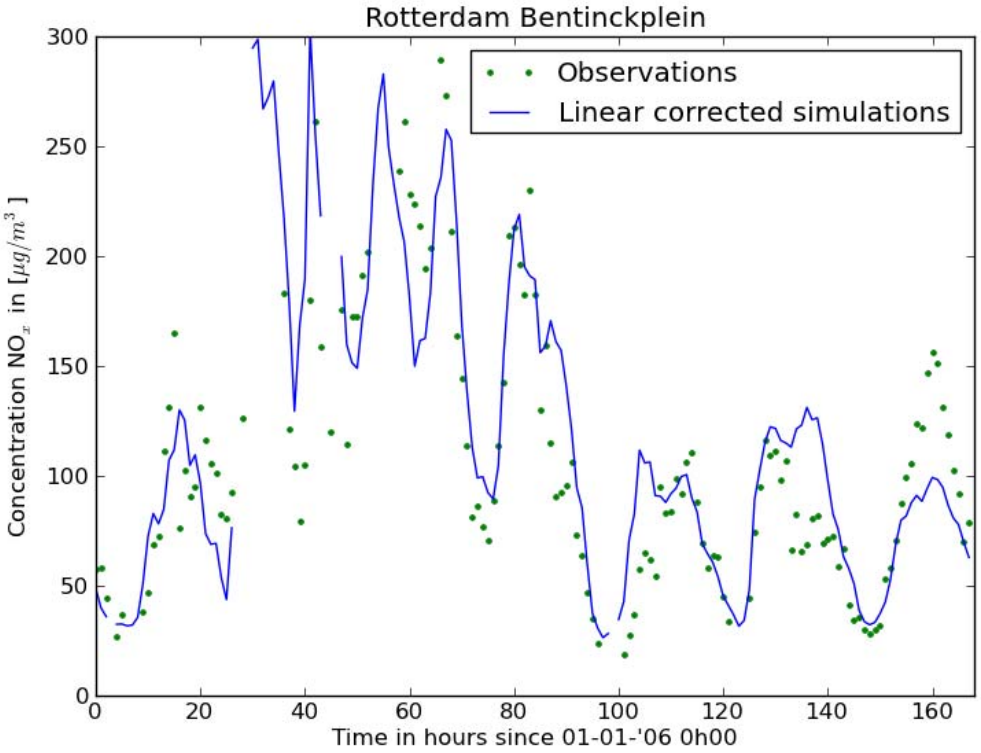


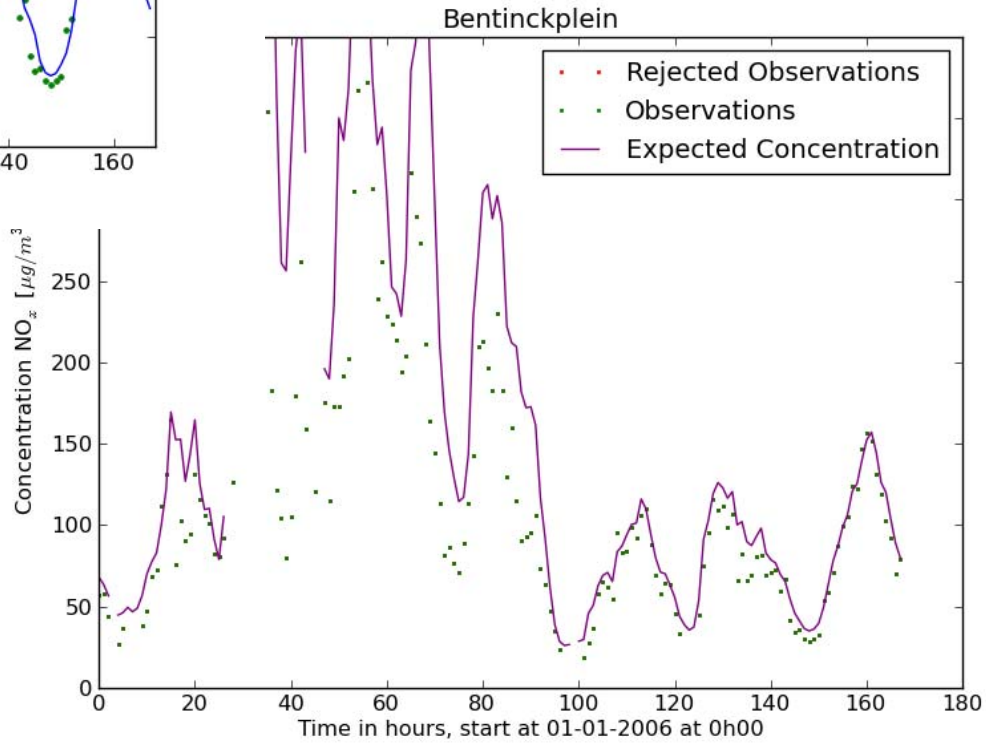
Further improving

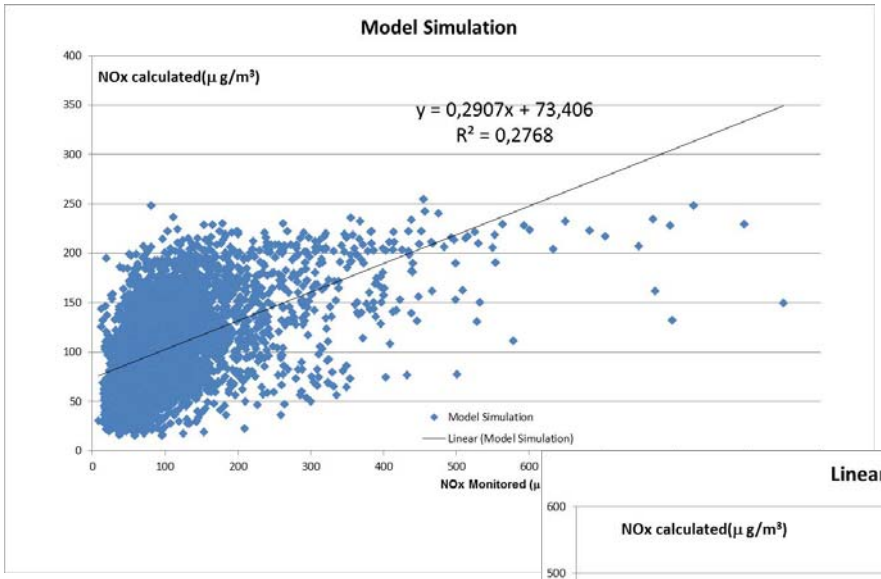
- Negative concentrations calculated in some areas
- Linear model calculates only one correction for the background for the whole area

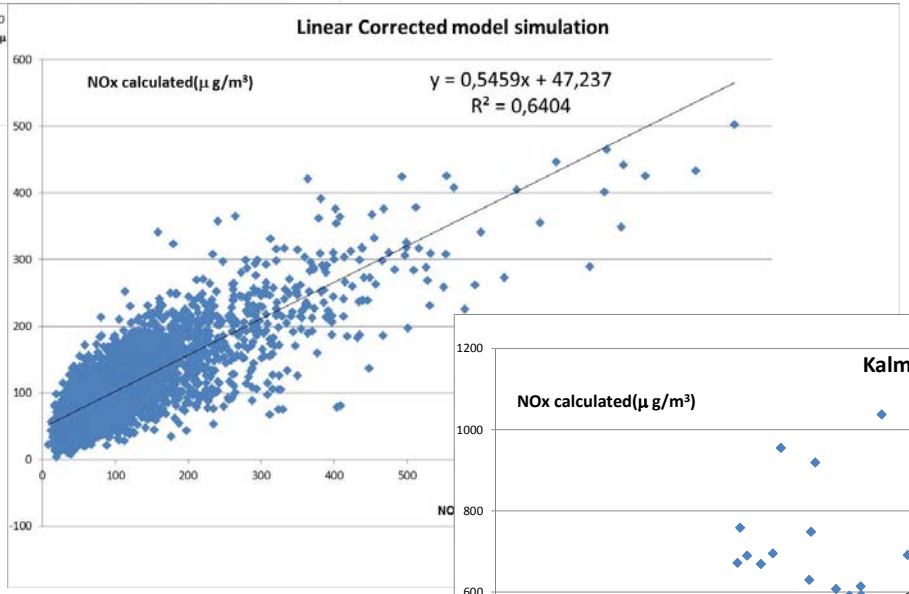
Kalman Filter

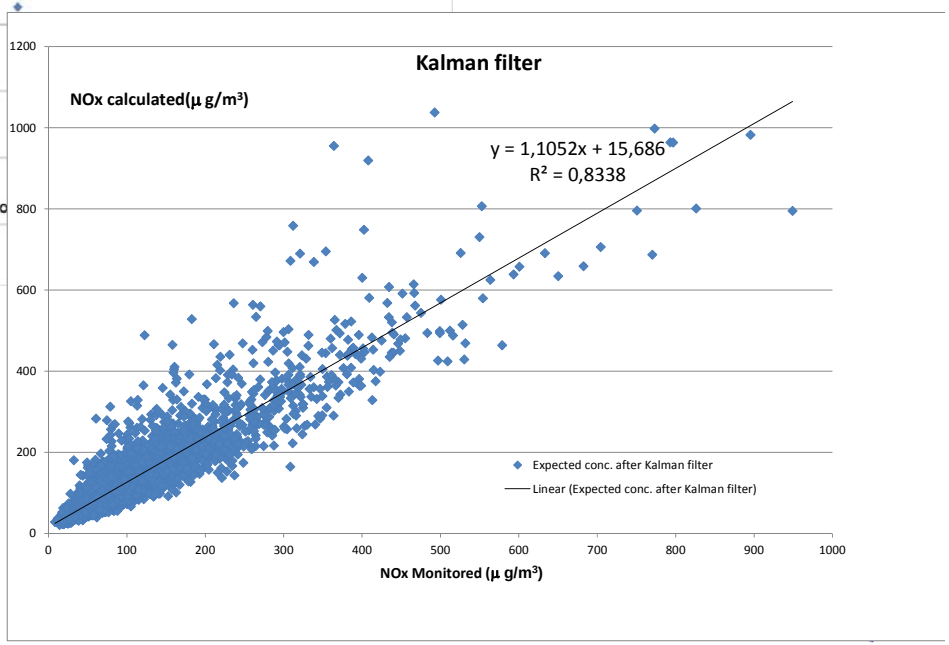
- Calculate concentration field for first hour using URBIS RT
- Minimalize differences between measured and calculated concentrations on monitoring sites
  - By adapting contribution from various source categories i.e. changing the emission strength
  - Paying attention to errors in measurements
    - Representativeness
- Calculate concentration field for next hour based upon new model

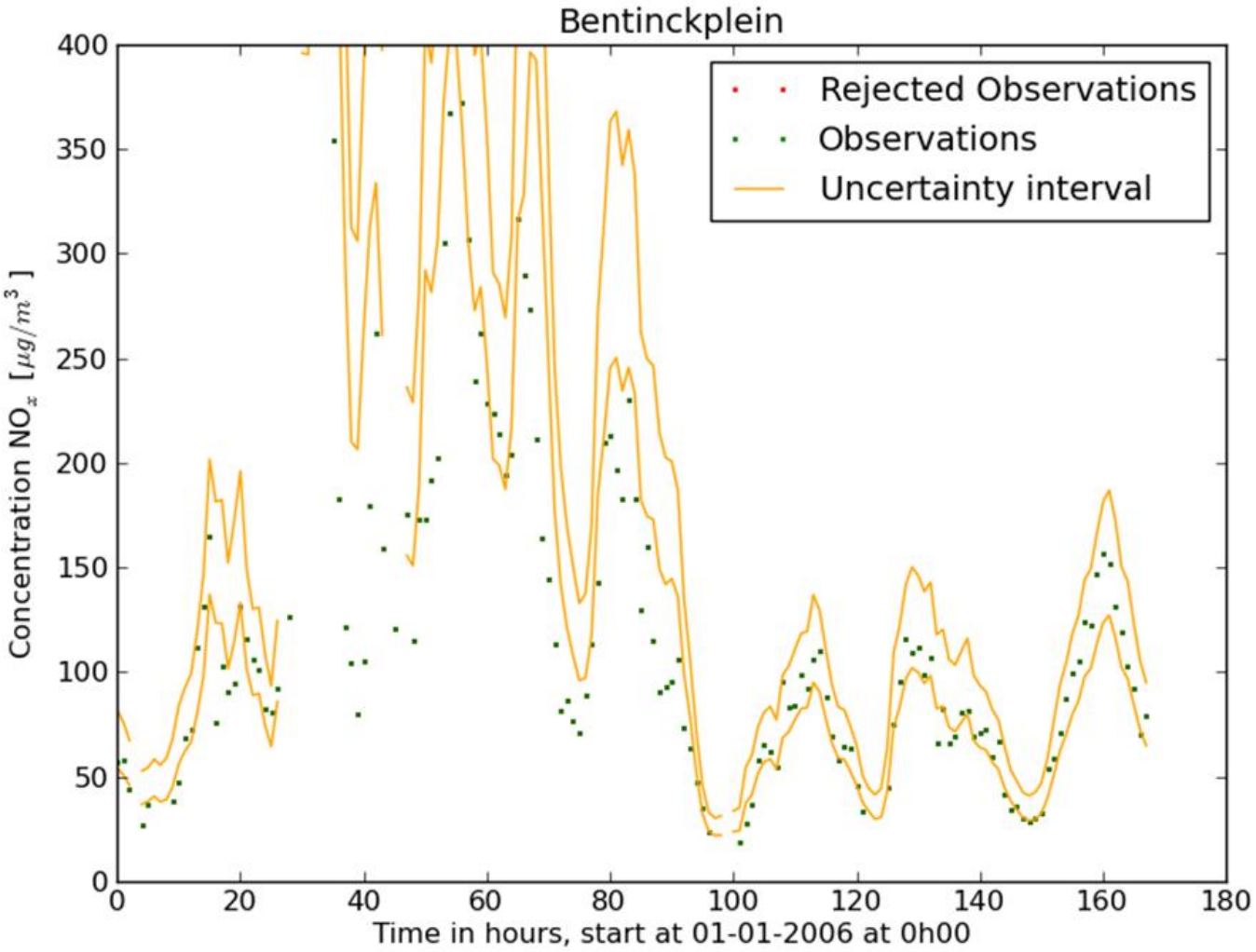

Rotterdam Bentinckplein
Observations
Linear corrected simulations
Concentration NO_x in $[\mu g/m^3]$
Time in hours since 01-01-'06 0h00
0
50
100
150
200
250
300
0
20
40
60
80
100
120
140
160


Bentinckplein
Rejected Observations
Observations
Expected Concentration
Concentration NO_x $[\mu g/m^3]$
Time in hours, start at 01-01-2006 at 0h00
0
50
100
150
200
250
0
20
40
60
80
100
120
140
160
180


Model Simulation
NOx calculated(µ g/m³)
y = 0,2907x + 73,406
R² = 0,2768
Model Simulation
Linear (Model Simulation)
NOx Monitored (µ

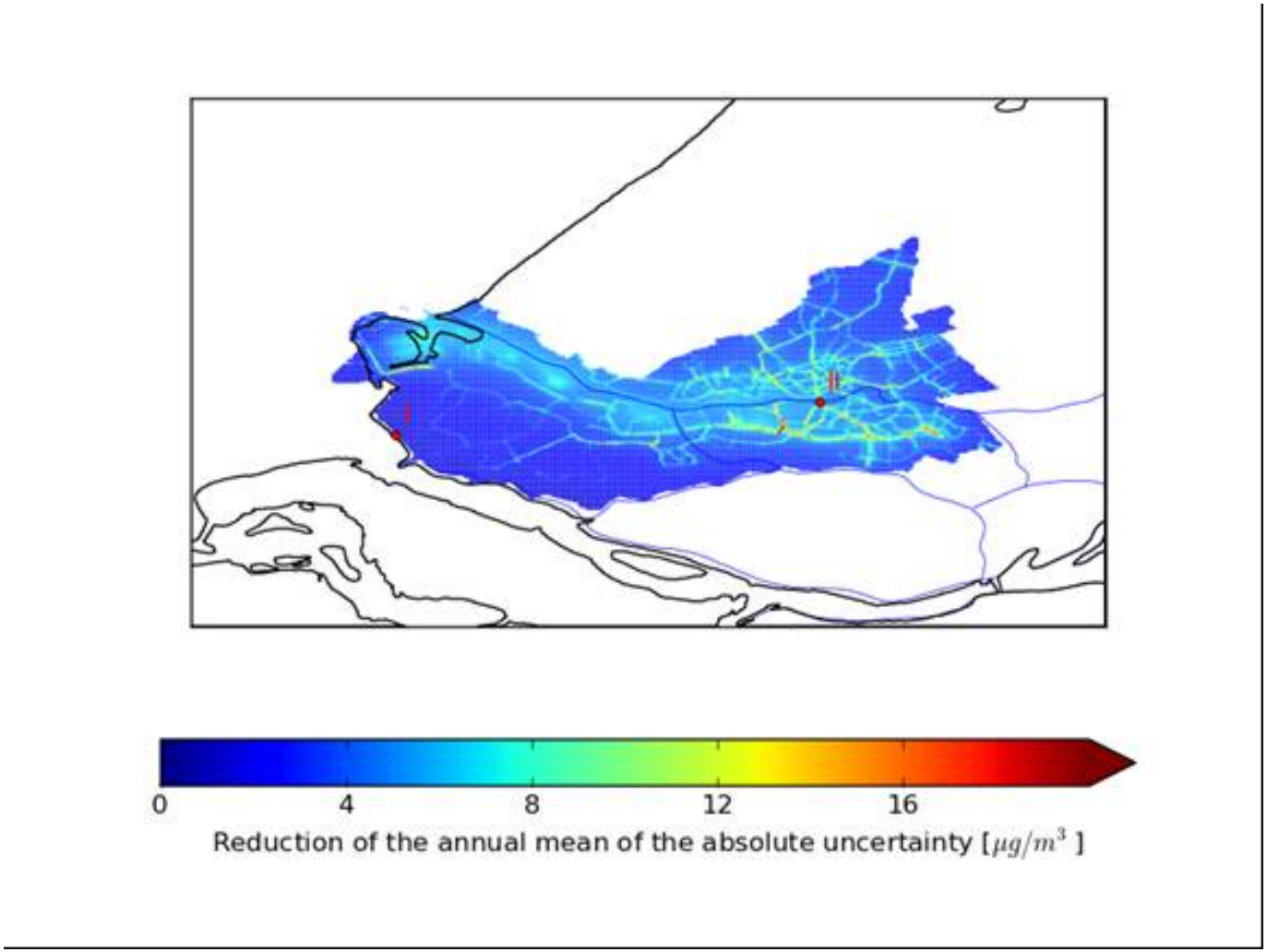

Linear Corrected model simulation
NOx calculated(µ g/m³)
y = 0,5459x + 47,237
R² = 0,6404


Kalman filter
NOx calculated(µ g/m³)
y = 1,1052x + 15,686
R² = 0,8338
Expected conc. after Kalman filter
Linear (Expected conc. after Kalman filter)
NOx Monitored (µ g/m³)


Bentinckplein
Rejected Observations
Observations
Uncertainty interval
Concentration NO_x [$\mu g/m^3$]
Time in hours, start at 01-01-2006 at 0h00
0
50
100
150
200
250
300
350
400
0
20
40
60
80
100
120
140
160
180

Kalman filtering in URBIS Real Time

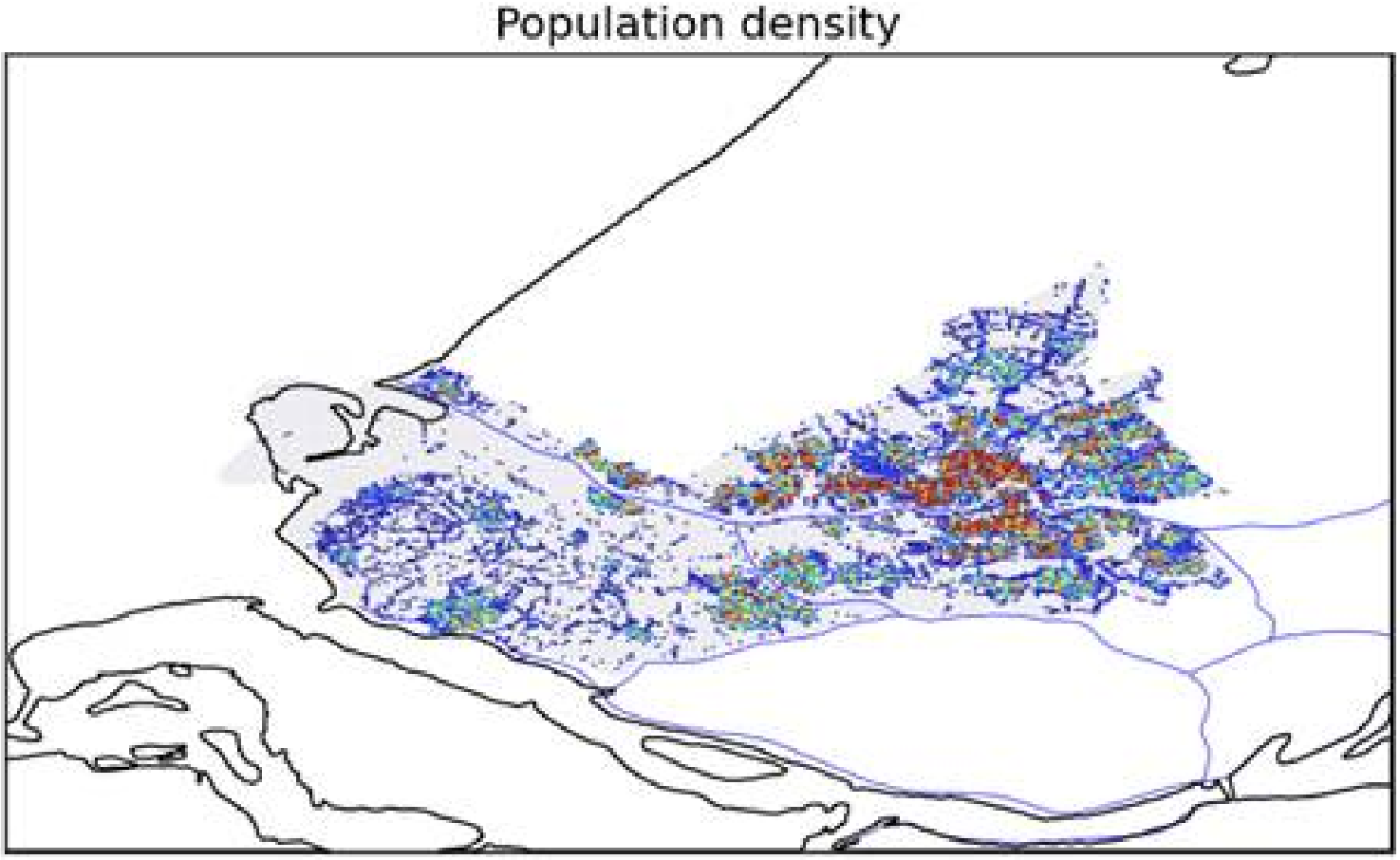
- Improved comparison with measurements
- Accuracy available
  - Optimise network

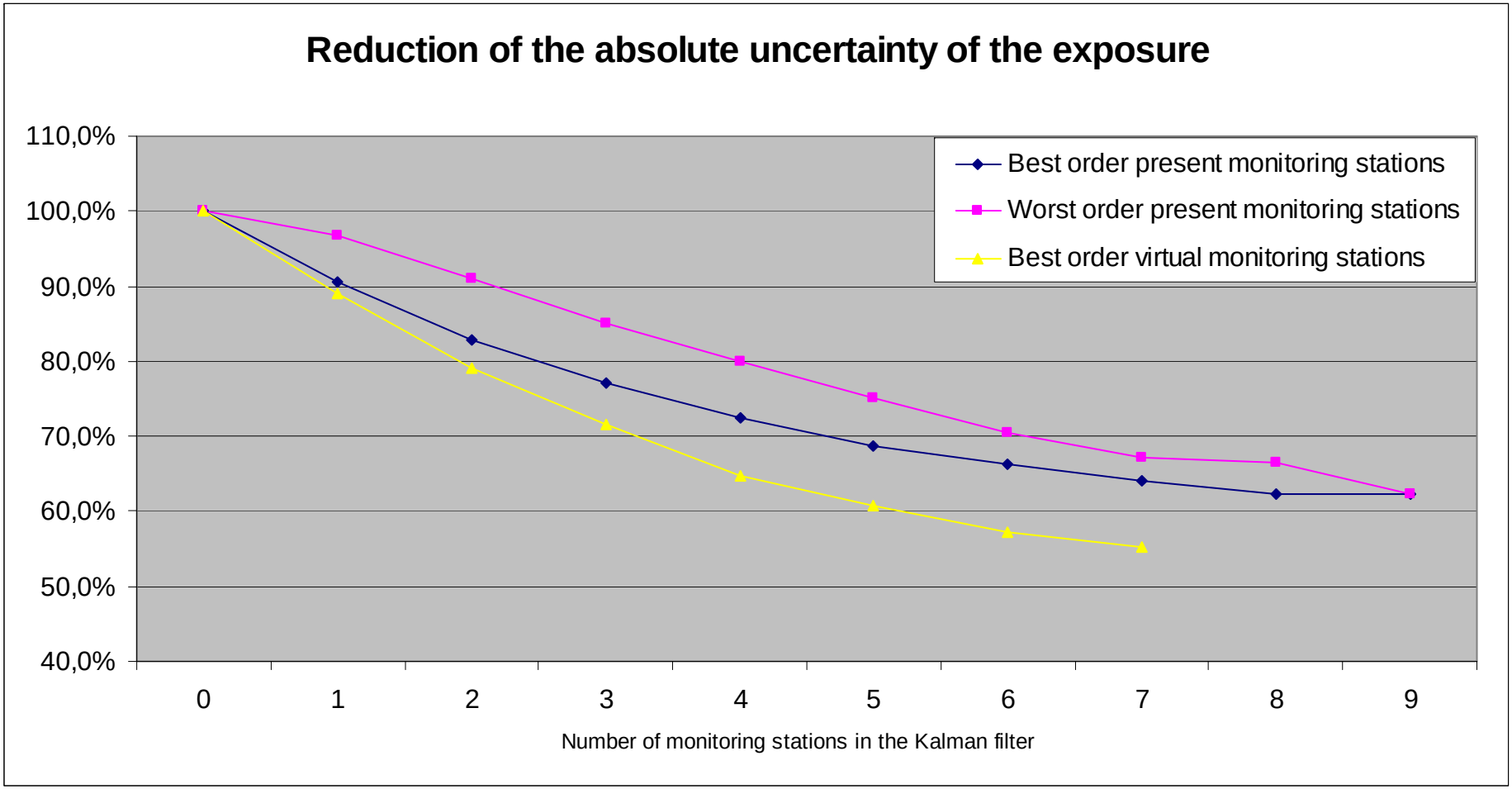

0
4
8
12
16
Reduction of the annual mean of the absolute uncertainty [$\mu g/m^3$]

Possibilities to optimise network

- Choose sites near specific emission sources
  - (for example road traffic, shipping)
- Choose site in areas with population

Optimise network for exposure assessment




Reduction of the absolute uncertainty of the exposure
110,0%
100,0%
90,0%
80,0%
70,0%
60,0%
50,0%
40,0%
0
1
2
3
4
5
6
7
8
9
Number of monitoring stations in the Kalman filter
Best order present monitoring stations
Worst order present monitoring stations
Best order virtual monitoring stations

Conclusions

- Real Time Urbis gives good results (correlations from 60-80%)
- Add Kalman filter:
  - Improve real time corrections (15% better exposure estimate)
  - Reduces the uncertainty in the contribution of the main roads (caused by the locations of the present stations)
  - Create an optimal setting of monitoring stations
  - Indications about weaknesses in the model
    - Emission
  - Bad monitoring stations

Contact

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