

A COMPARISON OF FIELD DATA, NUMERICAL CALCULATIONS AND WIND TUNNEL MEASUREMENTS IN AN URBAN ENVIRONMENT

TNO Environment, Energy and
Process Innovation

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TNO

- **Netherlands Organisation for Applied Scientific Research**

→ **Environmental (Air) Quality Department**

- Field experiments
- Numerical modelling
- Wind tunnel experiments

} Compare results

Rotterdam / Overschie

- Extensive field measurements performed: 2000 – present
 - Close to busy highway, also further away
 - $\text{NO}_x/\text{NO}_2/\text{PM}_{10}$ (some $\text{PM}_{2.5}$)
 - Extensive dispersion calculations
 - All relevant traffic parameters are known
 - Meteo station at airfield (5 km)
- **Present aim: perform wind tunnel measurements to compare to field- and numerical data**

Locations



Measuring locations

Locations

A13 highway, 150000 cars/day, 15% trucks



Data sets

- **Open field:**

- hourly $\text{NO}_x/\text{NO}_2/\text{PM}_{10}/\dots$ data at 50 & 200 meters
- Effects of 1 and 2 noise barriers (WT only)
- Effects additional mixing between noise barriers (WT only)
- Effects of trees on 1 side (WT only)

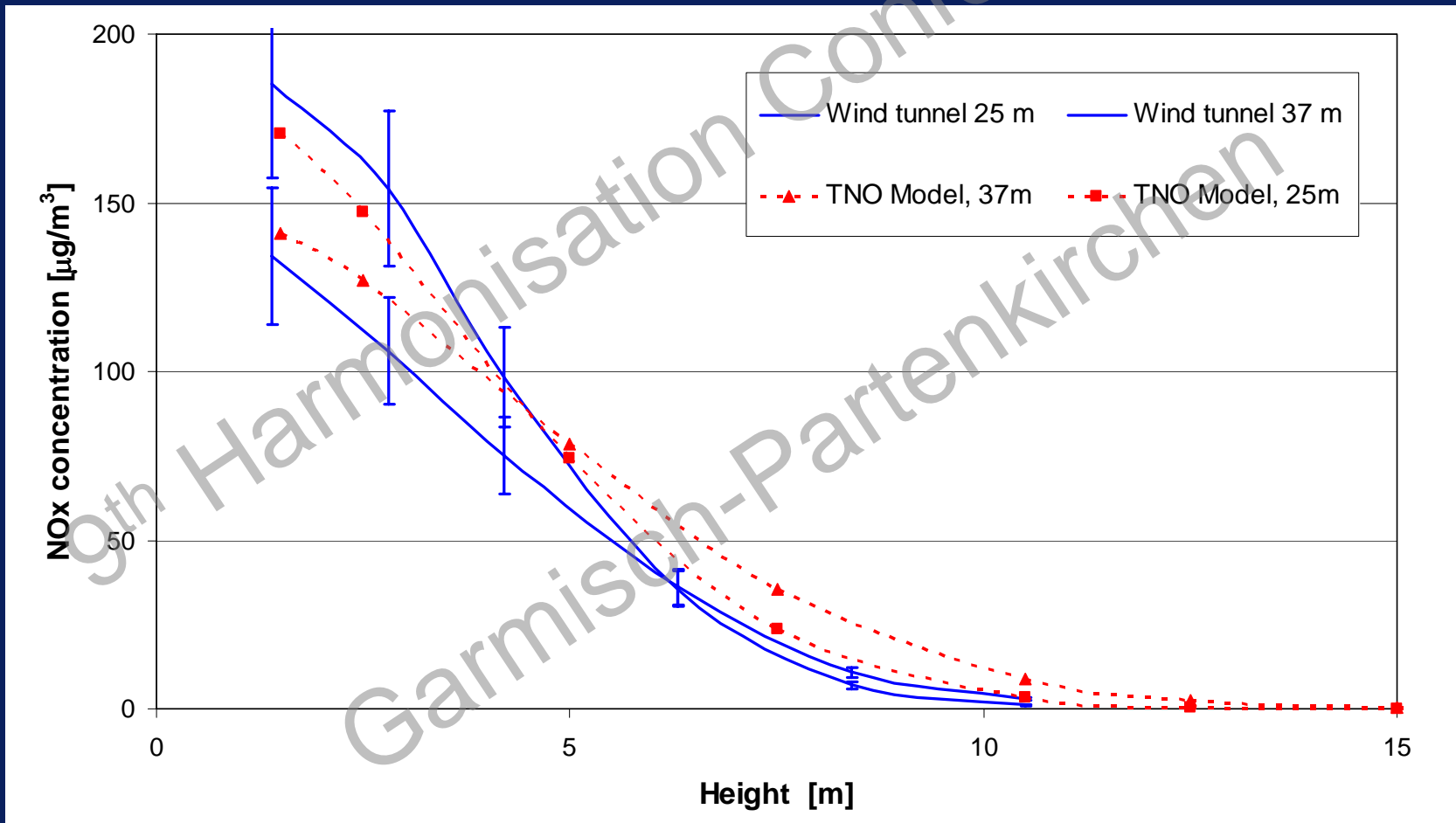
- **Urban location:**

- hourly data at 40 & 200 meters
- 14-day average data at 40 locations
- Effects of building types (WT only)

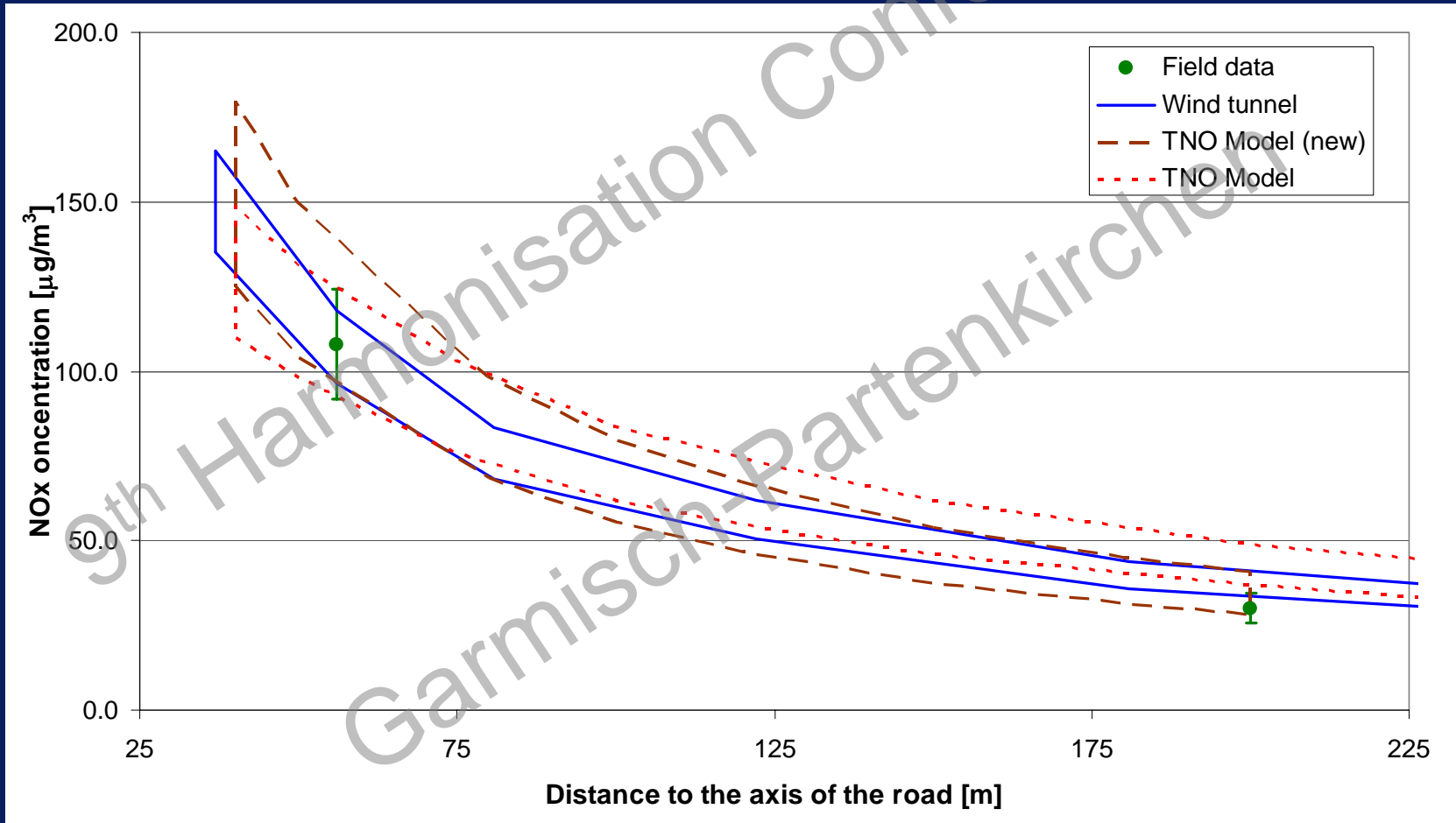
Open field



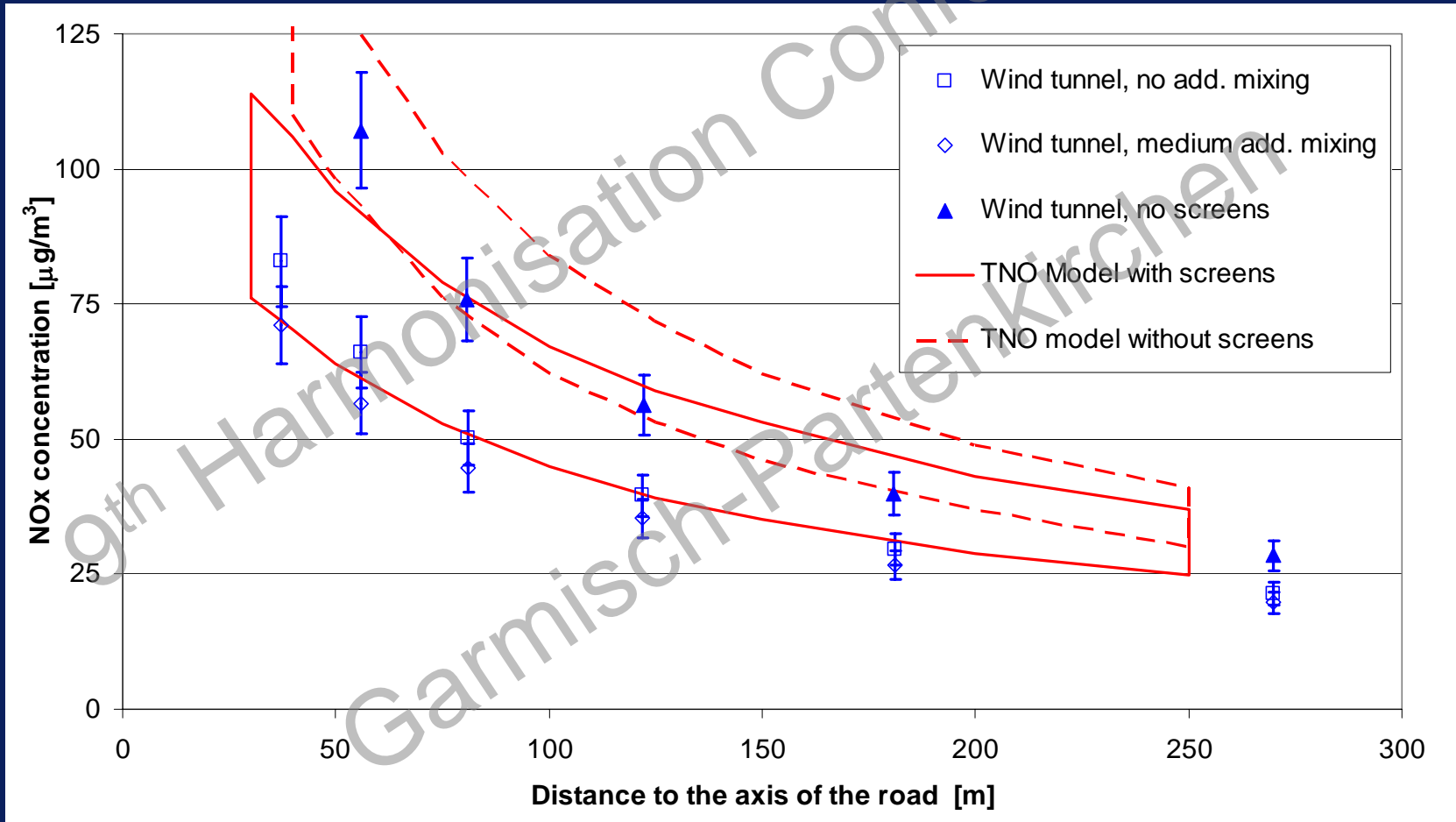
Vertical concentration distribution



Comparison of data open field



Effect of noise barrier open field



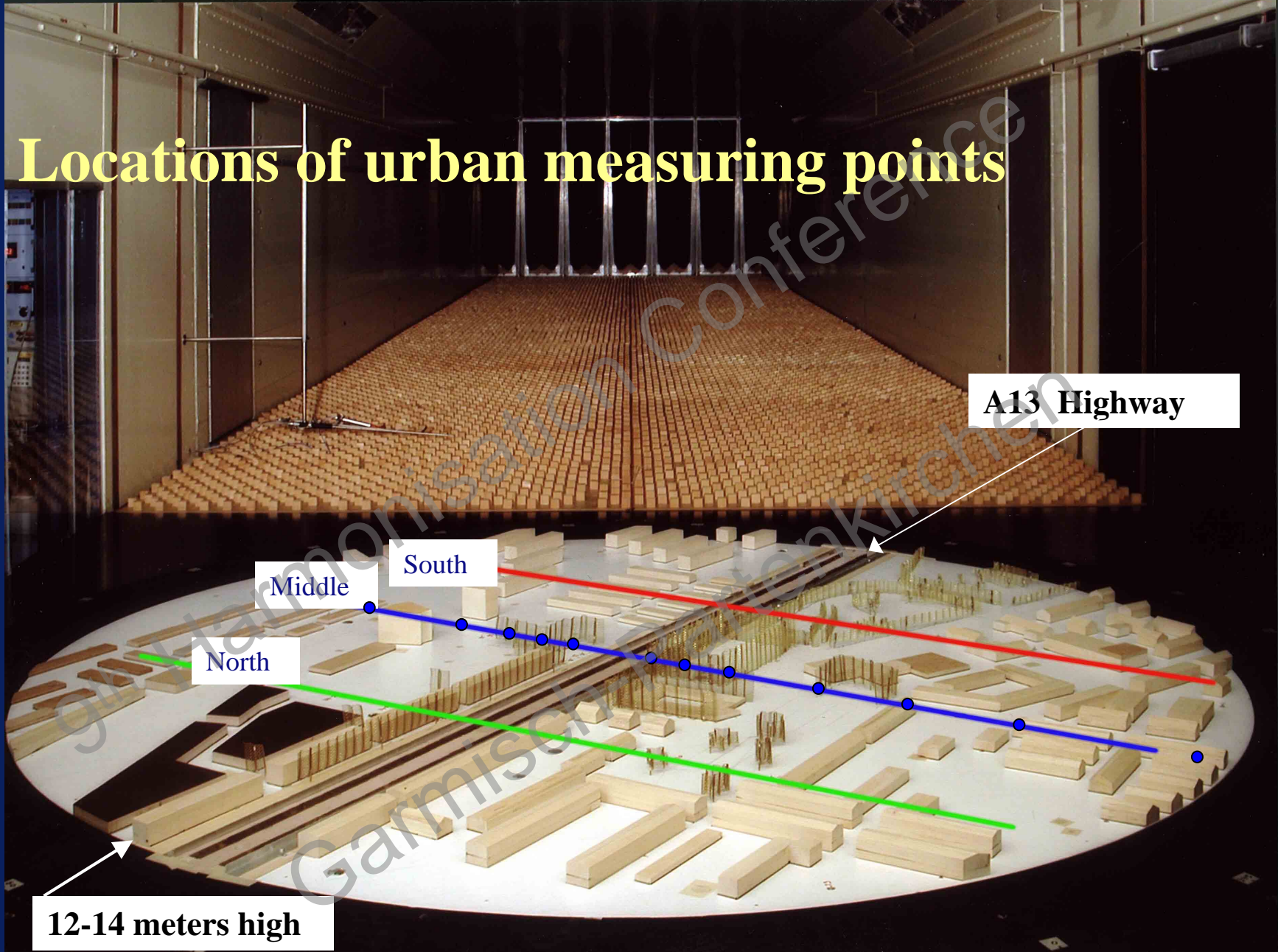
Overschie



TNO Wind tunnel, Rotterdam, Overschie



Locations of urban measuring points



Locations of urban measuring points

Shielding by building

A13 Highway

Middle

South

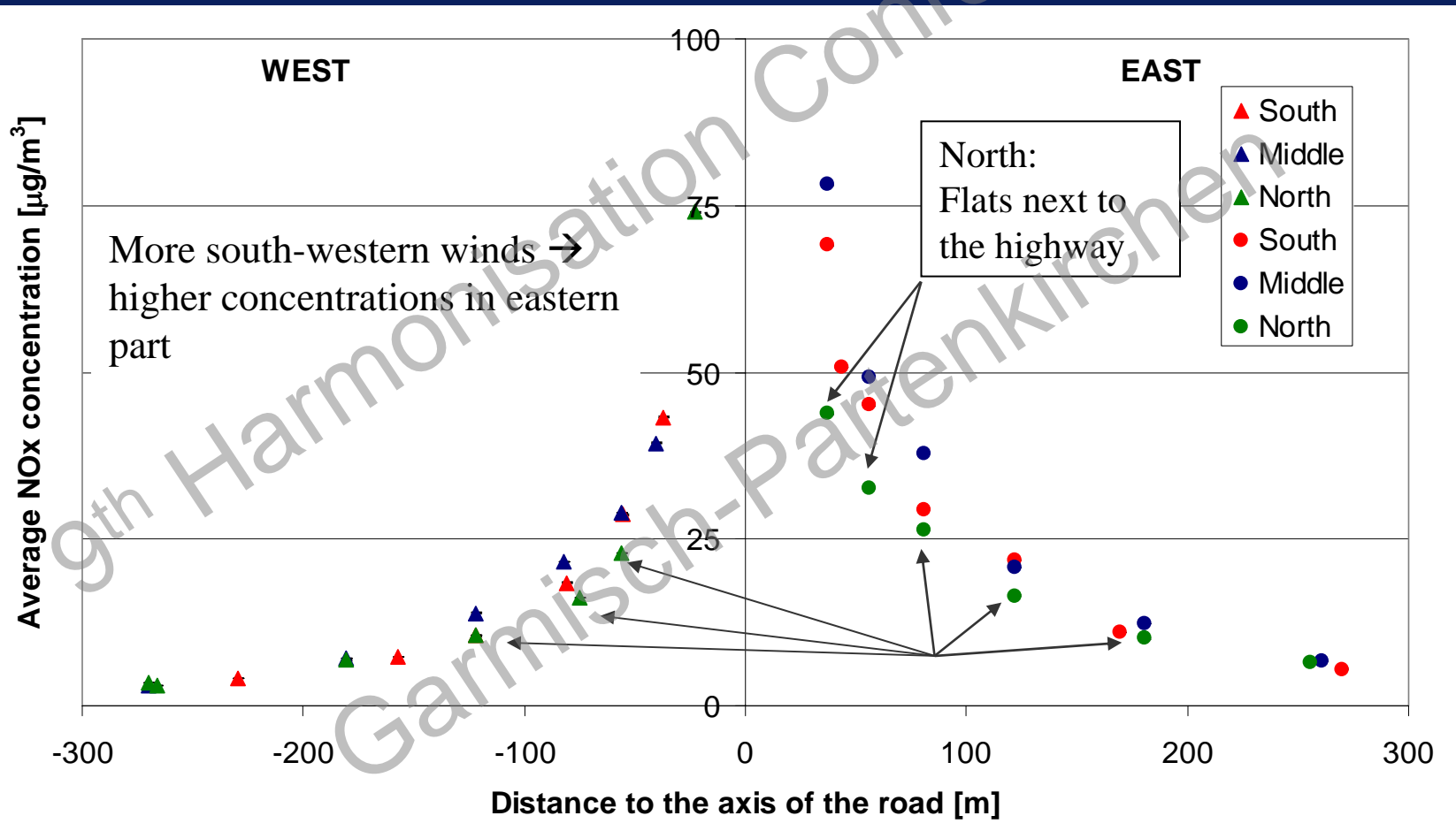
North

12-14 meters high

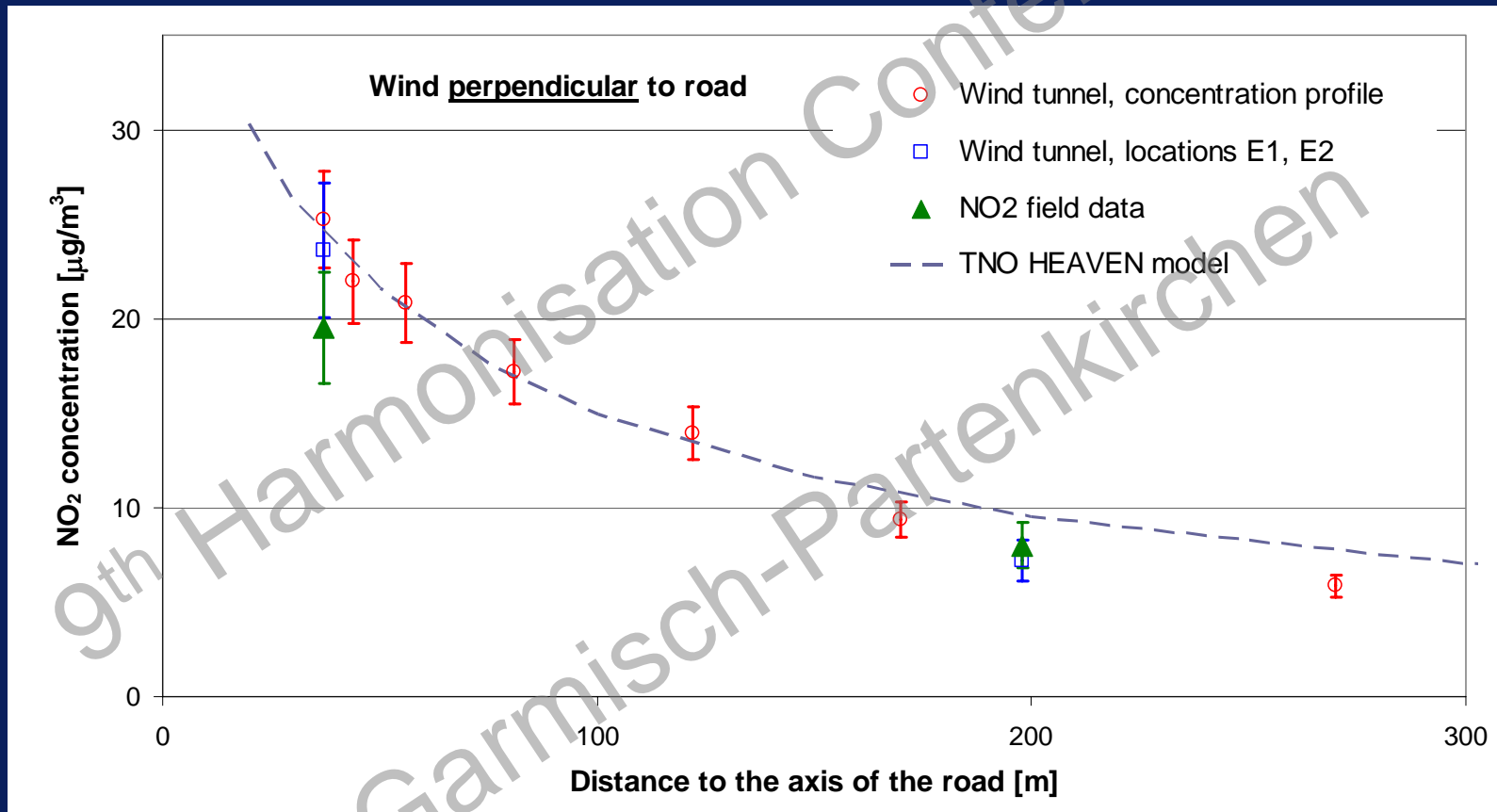
Shielding by building



NO_x WT data urban environment, 1 year emission & meteo data



Comparing NO₂ contribution, cross wind, yearly averaged



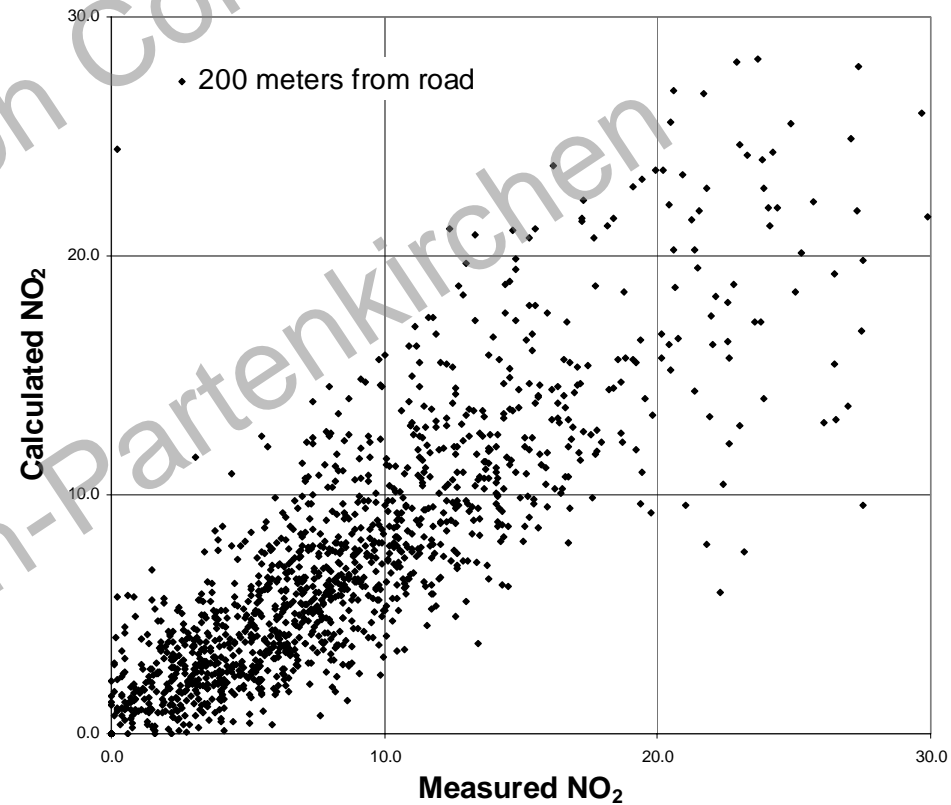
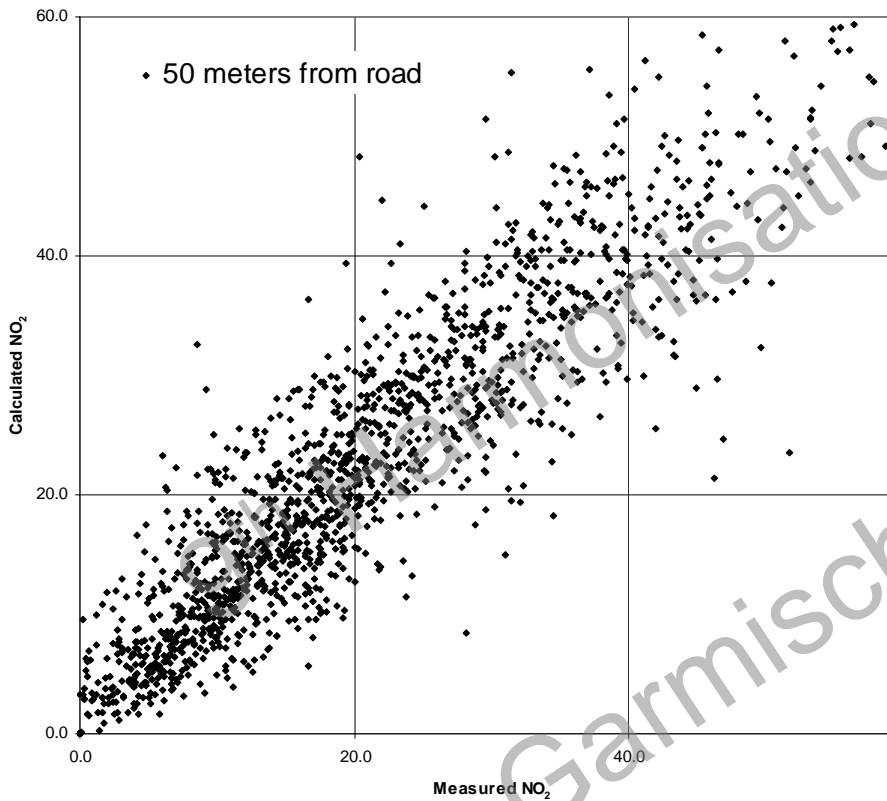
NO_x → NO₂ conversion

- TNO uses a very simple empirical relation:

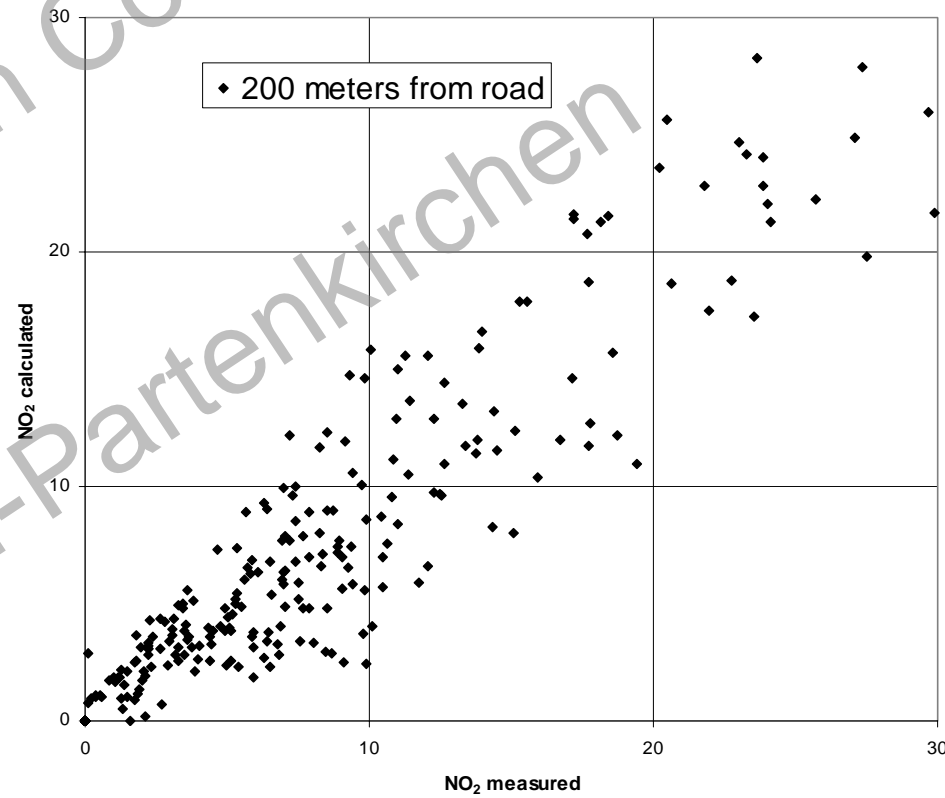
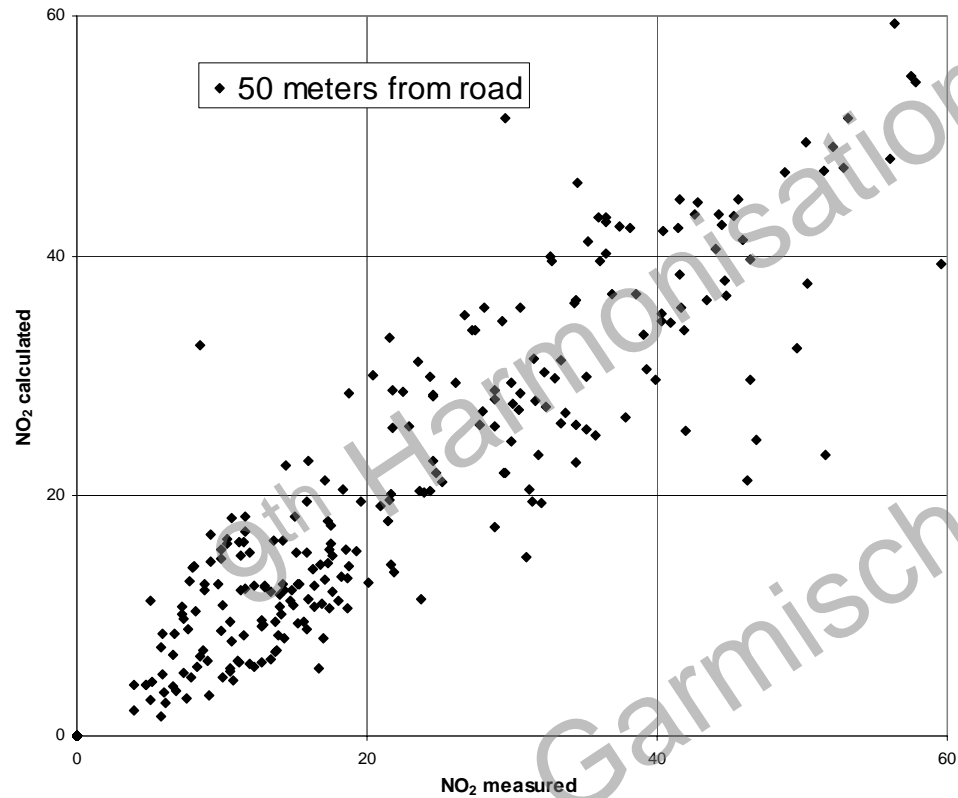
$$[NO_2] = f \cdot [NO_x] + \beta [O_3]_{background} \frac{[NO_x]}{[NO_x] + K}$$

- The relation was tested by using measured NO_x and O₃ to calculate NO₂ and compare this to experimental data

Test of conversion, open field



Test of conversion, urban environment



NO_x → NO₂ conversion

- **Overall satisfactory results of conversion scheme**
- **No significant differences inside city / out in open field**
- **Scheme is very robust, applicable in**
 - Yearly average concentrations;
 - Hourly average concentrations;
 - Conversion of NO_x measured in wind tunnel;

Conclusions and outlook

- **Very satisfactory combination of field, numerical and wind tunnel data**
- **Complete the analyses**
- **More detailed study of urban dispersion**
- **Pollution abatement in Dutch cities**