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

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  - Field experiments
  - Numerical modelling
  - Wind tunnel experiments

\{ Compare results \}
Rotterdam / Overschie

- Extensive field measurements performed: 2000 – present
- Close to busy highway, also further away
- NO$_x$/NO$_2$/PM10 (some PM2.5)
- 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

The Netherlands

Measuring locations
Locations

A13 highway, 150000 cars/day, 15% trucks

Open field

Urban location
Data sets

- **Open field:**
  - hourly NO\textsubscript{x}/NO\textsubscript{2}/PM\textsubscript{10}/… 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

![Graph showing vertical concentration distribution with different data points and lines representing Wind tunnel 25 m, Wind tunnel 37 m, TNO Model, 37m, and TNO Model, 25m.](image)
Comparison of data open field

![Graph showing NOx concentration vs. distance to the axis of the road]

- Field data
- Wind tunnel
- TNO Model
- TNO Model (new)
Effect of noise barrier open field

![Graph showing NOx concentration vs. distance to the axis of the road.]

- Wind tunnel, no add. mixing
- Wind tunnel, medium add. mixing
- Wind tunnel, no screens
- TNO Model with screens
- TNO model without screens
Overschie
TNO Wind tunnel, Rotterdam, Overschie
Locations of urban measuring points

- North
- Middle
- South

A13 Highway

12-14 meters high
Locations of urban measuring points

- North
- Middle
- South
- A13 Highway

Shielding by building

12-14 meters high
Shielding by building
NOx WT data urban environment, 1 year emission & meteo data

More south-western winds → higher concentrations in eastern part

North: Flats next to the highway

Average NOx concentration [µg/m³]

Distance to the axis of the road [m]
Comparing NO$_2$ contribution, cross wind, yearly averaged

Wind perpendicular to road

- Wind tunnel, concentration profile
- Wind tunnel, locations E1, E2
- NO$_2$ field data
- TNO HEAVEN model

NO$_2$ concentration [µg/m$^3$]

Distance to the axis of the road [m]
NOx $\rightarrow$ 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 NOx and O3 to calculate NO2 and compare this to experimental data.
Test of conversion, open field

- 50 meters from road
- 200 meters from road

Calculated NO₂ vs. Measured NO₂
Test of conversion, urban environment

- 50 meters from road
- 200 meters from road
NOx $\rightarrow$ 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 NOx 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