9th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes

Garmisch-Partenkirchen, Germany
June 1-4, 2004

Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes

Dispersion modelling has proved to be a very effective tool to assess the environmental impact of human activities on air quality already at the early planning stage.

Only models can give detailed information on the distribution of pollutants with high spatial and temporal resolution, while they allow the decision-maker to devise a range of scenarios, in which the various processes determining the environmental impact can be easily simulated and changed.

CITY - DELTA
European Modelling Exercise

An Inter-comparison of long-term model responses to urban-scale emission-reduction scenarios

The CITY-DELTA conclusions will provide guidance on how urban air-quality could be included in a Europe-wide evaluation of the cost-effectiveness of emission control strategies. CAFE expects information from integrated assessment models on the optimal (cost-effective) balance between emission control measures that should be taken at the European/Community level and measures that should be best left to cities.

EVALUATION OF MODELLING RESULTS FOR URBAN AREAS IN TERMS OF APPLICATION FOR AIR POLLUTION MANAGEMENT

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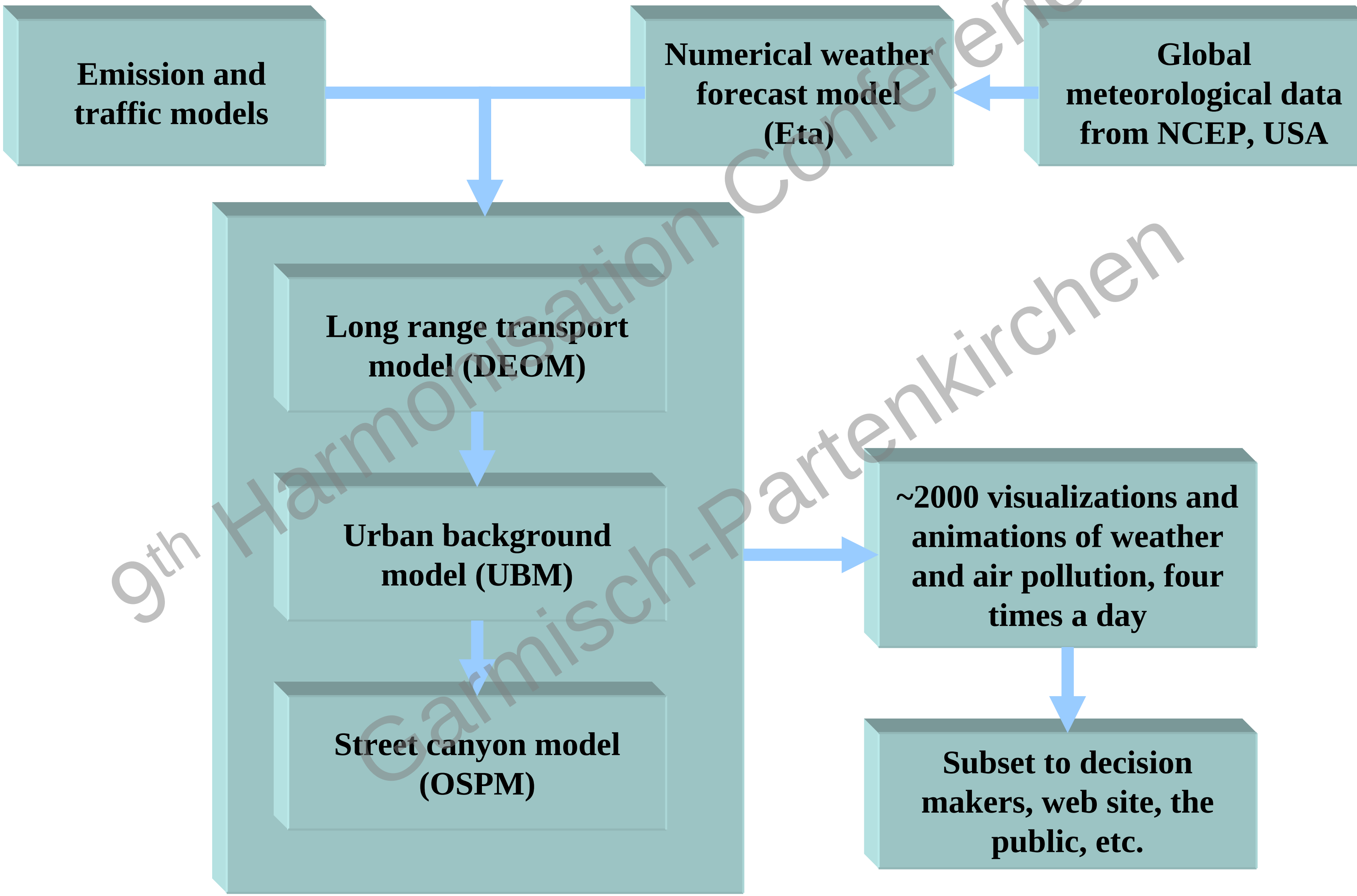
- An important criterion for model application for air pollution management is a detailed evaluation of its performance and especially of the model responses to the driving parameters.

- Although, the main focus of CITY-DELTA is on particulate matter, ozone and NO_2 pollution, which to large extend are governed by large scale processes, the urban aspect leads also to the question how well the different models can deal with the pollutants emitted directly within the urban areas. This question is especially of relevance taking into account the need of evaluation of the effectiveness of local measures to reduce the impact of air pollution on human exposure and its other adverse effects.

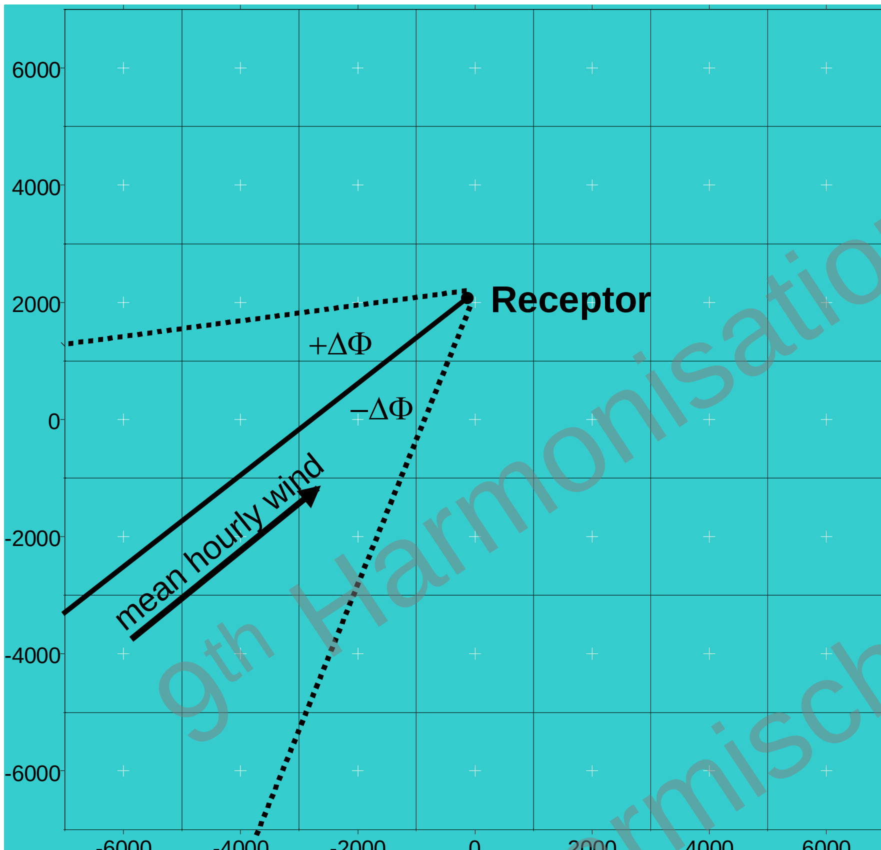
Conclusions

- More QUESTIONS than ANSWERS

The THOR integrated model system



Urban Background Model (BUM) - High resolution dispersion modelling but simplified chemistry. Applied only for the urban area.



$$C = \int \frac{Q(x)dx}{u\ \sigma_z(x)} + \textit{rural background}$$

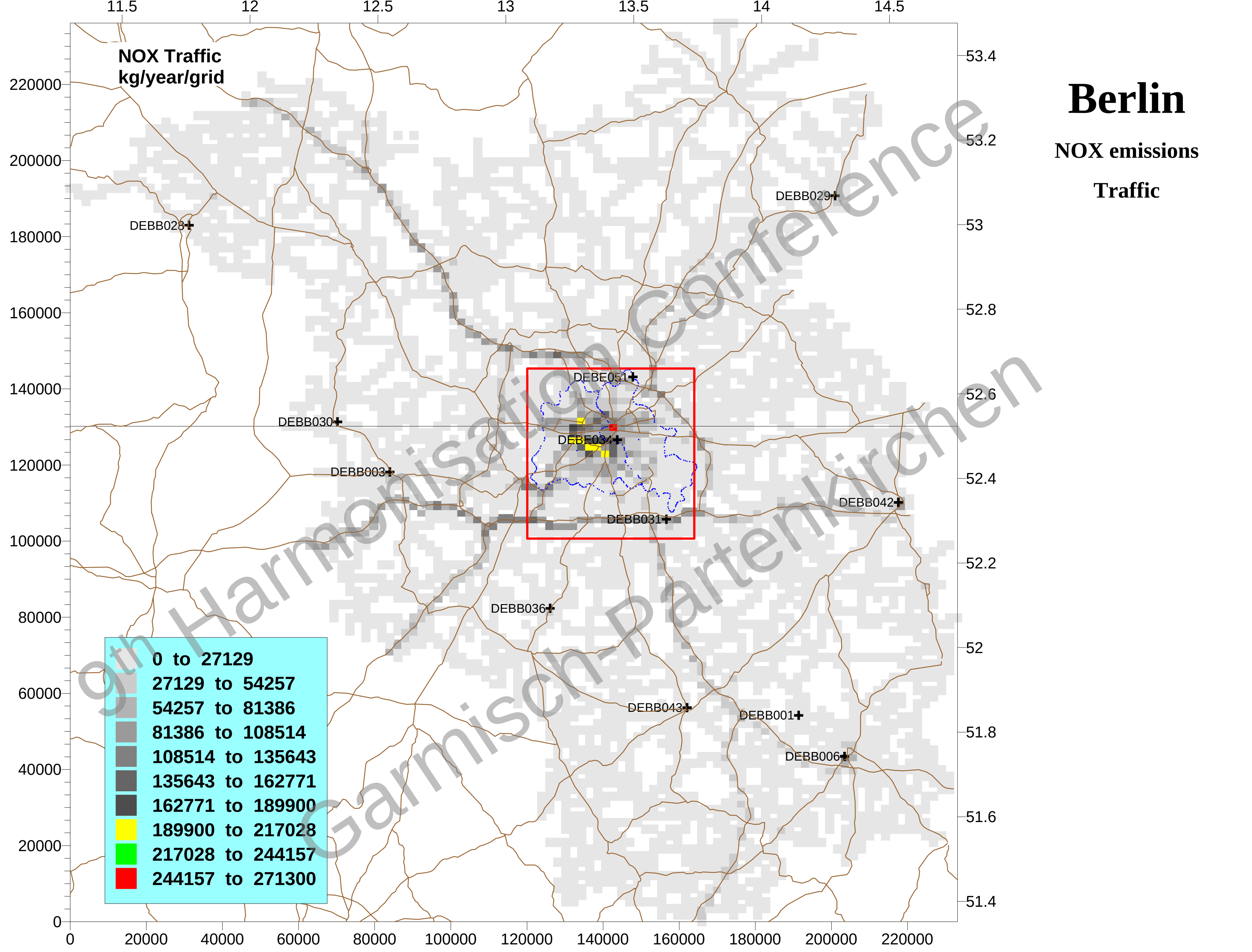
numerical integration with a step of 250 m

$$\sigma_z(x) = h_o + \int \sigma_w(h)\cdot dx; \quad h = \sigma_z(x)$$

$$\sigma_z(x) \le h_{mix}$$

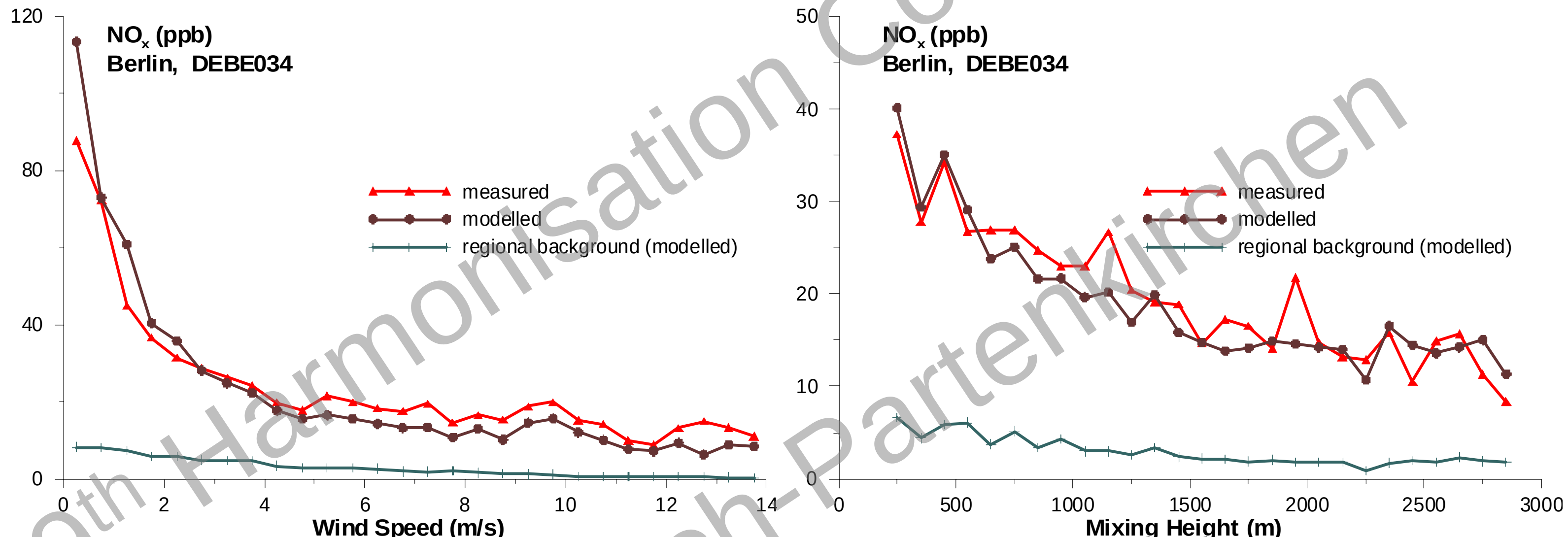
$$\sigma_w^2 = (\alpha \cdot u)^2 + \sigma_{conv}^2$$

$$\overline{C} = \frac{1}{2\Delta\Phi}\int_{-\Delta\Phi}^{+\Delta\Phi} C\,d\Phi$$



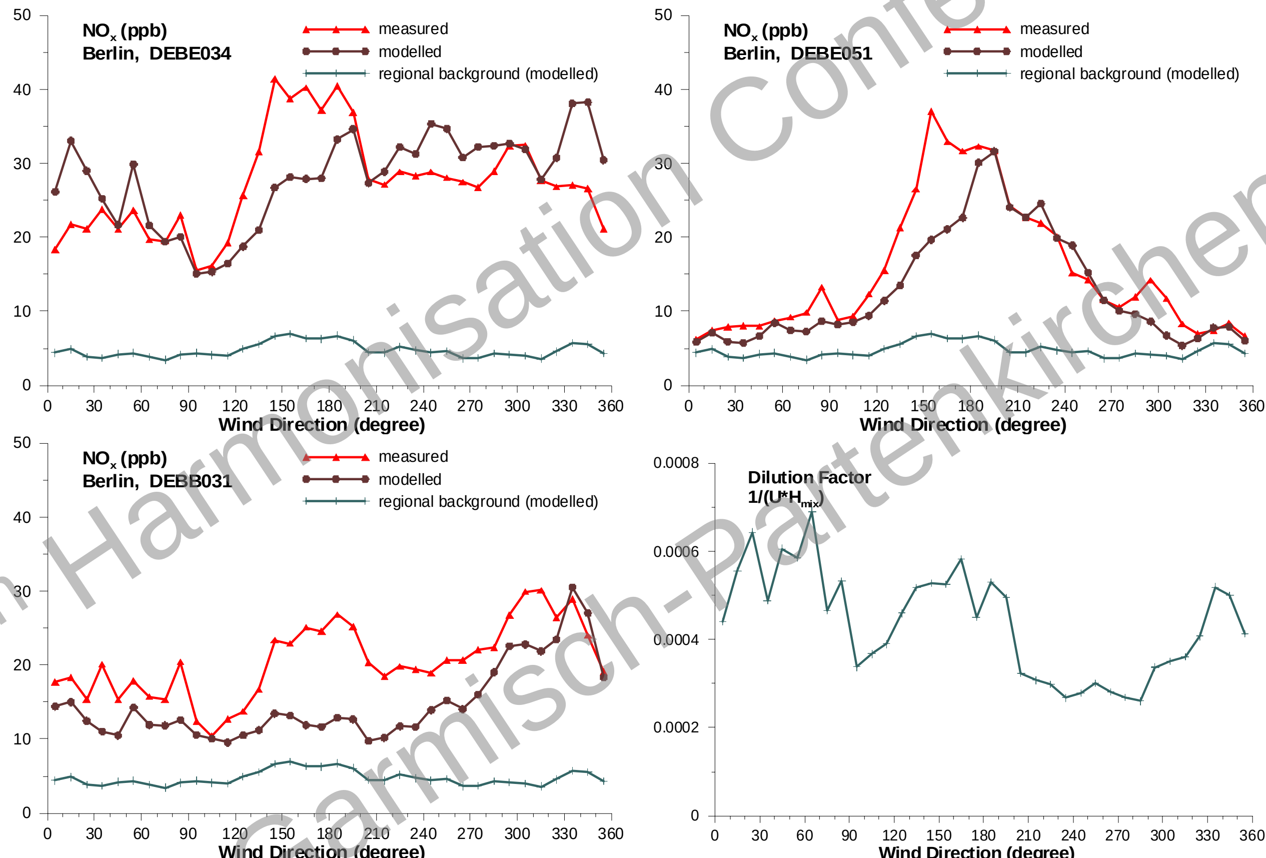
Berlin
NOX emissions
Traffic
NOX Traffic
kg/year/grid
0 to 27129
27129 to 54257
54257 to 81386
81386 to 108514
108514 to 135643
135643 to 162771
162771 to 189900
189900 to 217028
217028 to 244157
244157 to 271300
DEBB028
DEBB029
DEBE051
DEBB030
DEBE034
DEBB003
DEBB042
DEBB031
DEBB036
DEBB043
DEBB001
DEBB006

Evaluation of the modelling results focusing on the model response to the most important forcing parameters, i.e. the emission data and the meteorological conditions.

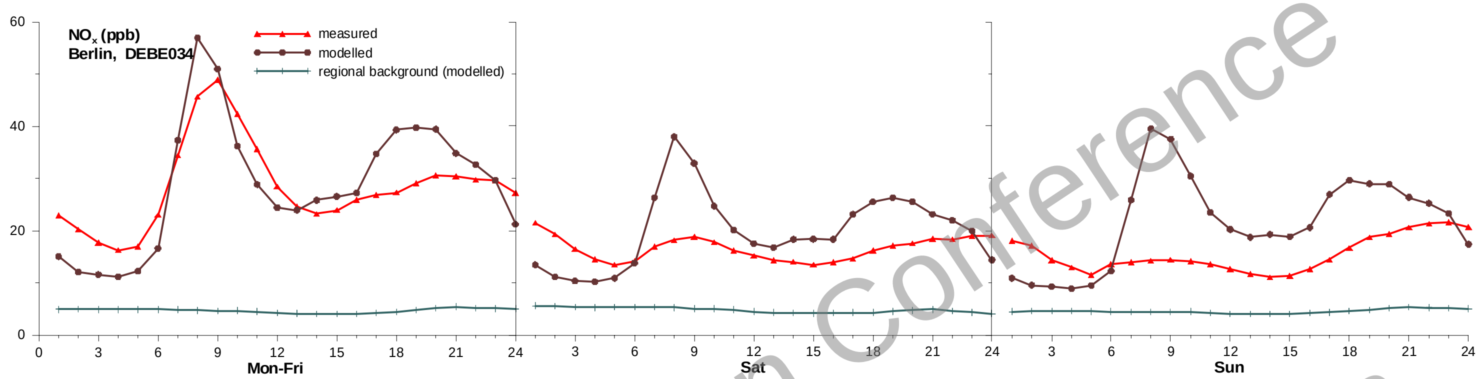


Variation of the measured and modelled NO$_x$ concentrations with wind speed and mixing height. Results are shown for the Berlin monitoring station DEBE034 (city centre). The modelled regional background contribution is shown too.

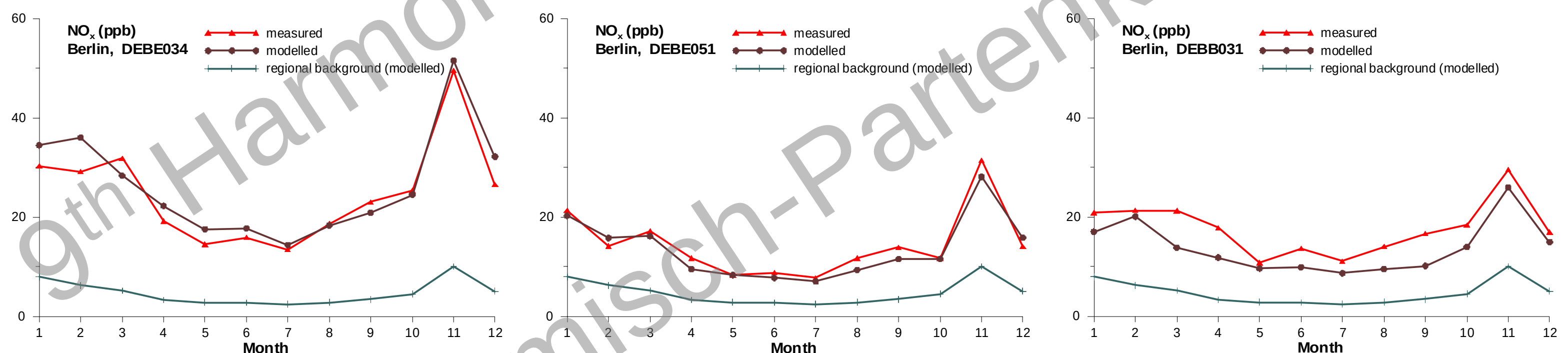
The variation of pollution levels in response to emissions cannot be evaluated directly, but some information can be gained by examining the dependence between the concentrations and some parameters, which have influence on emissions.



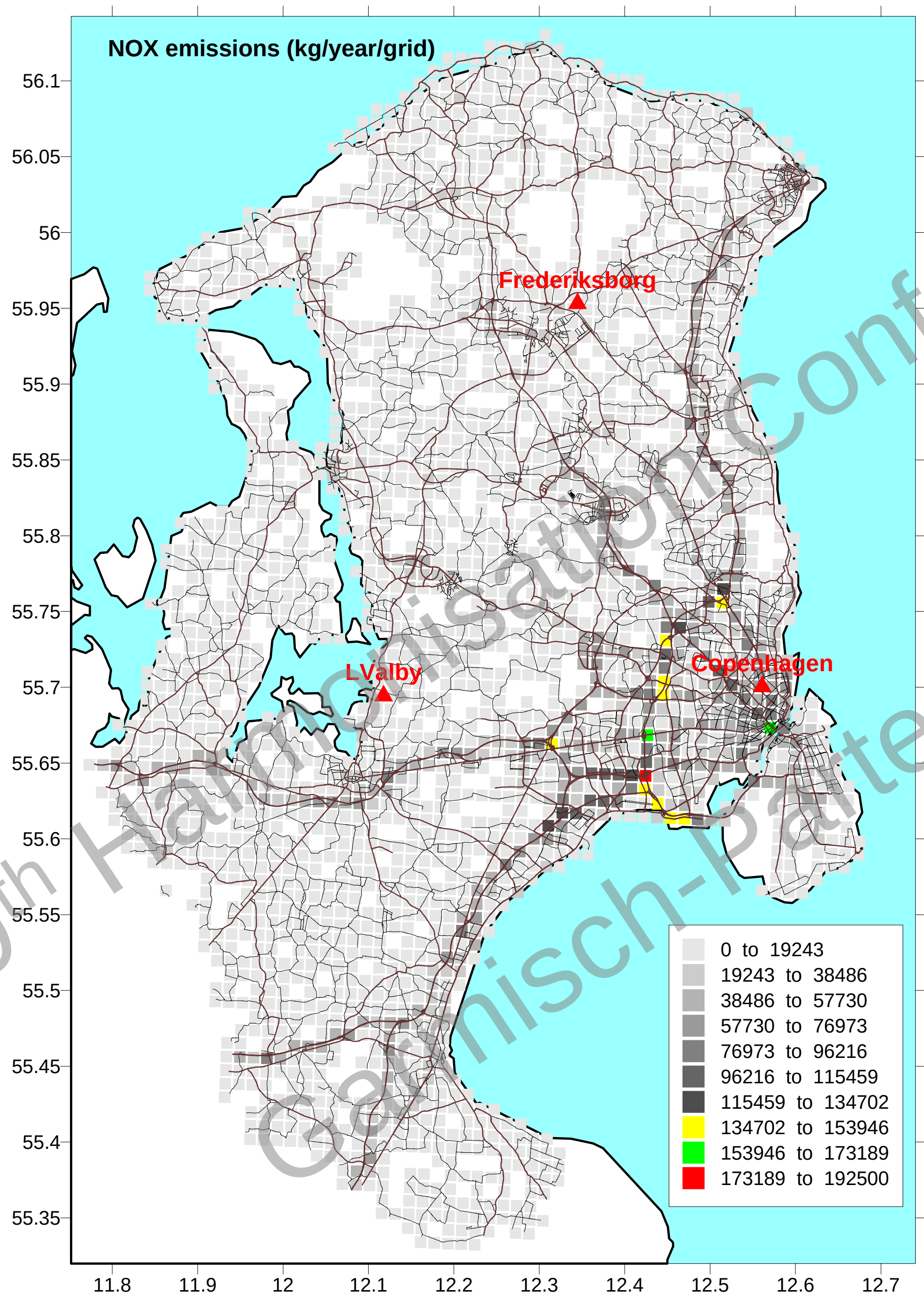
Variation of the measured and modelled NO_x concentrations with wind direction. Results are shown for 3 monitoring stations: DEBE034 - city centre, DEBE051 – north suburb, DEBB031 – south of the city border. The modelled regional background contribution is shown too. Additionally, the effective dilution factor defined as the inverse of the product of wind speed and mixing height, is shown as well.



Hourly variation of measured and modelled NO$_x$ concentrations at the station DEBE034. The time variation of emissions implemented in the model doesn't reproduce the time variation observed during the weekends.



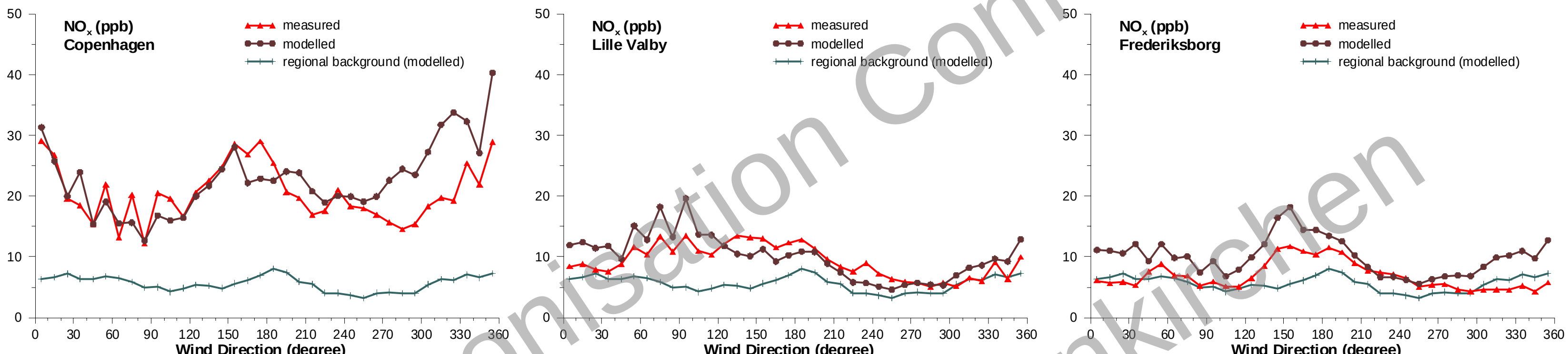
Monthly variation of measured and modelled NO$_x$ concentrations at the Berlin stations.



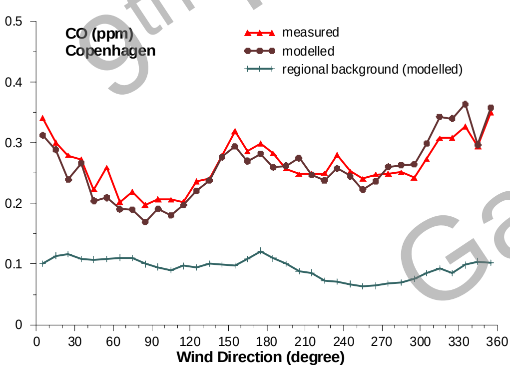
Copenhagen

NOX emissions

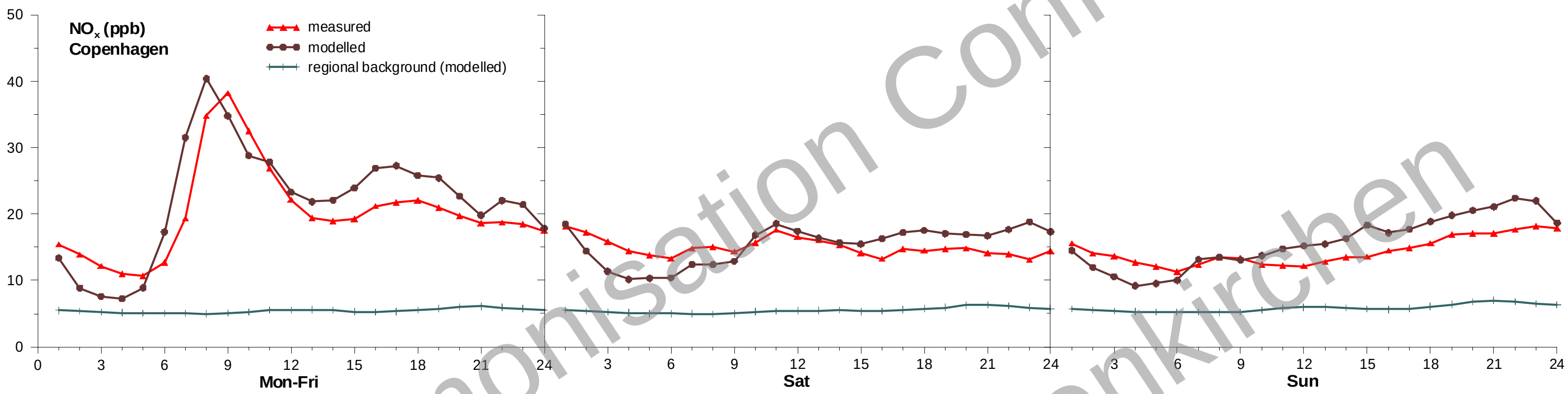
Traffic



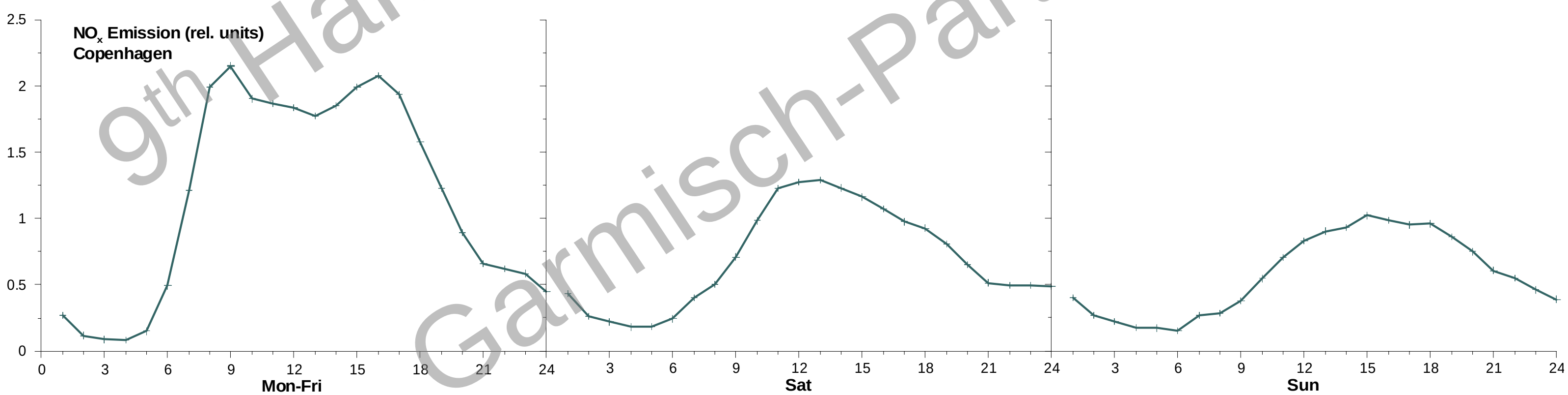
Variation of the measured and modelled NO_x concentrations with wind direction. Results are shown for 3 monitoring stations: Copenhagen - city centre, Lille Valby –West of Copenhagen, Frederiksborg – North of Copenhagen. The modelled regional background contribution is shown too.



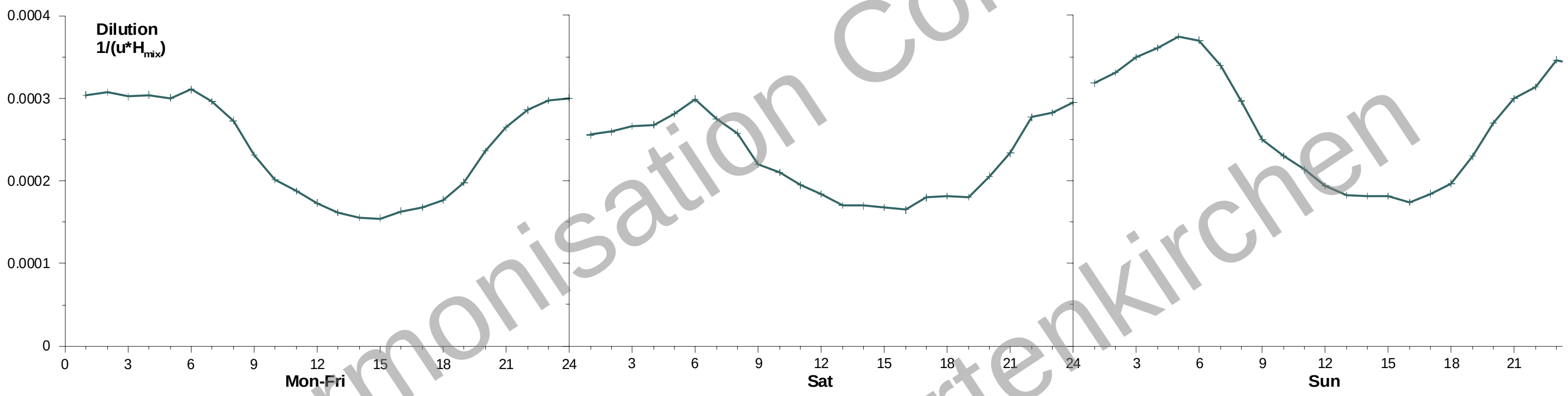
Variation of the measured and modelled CO concentrations with wind direction. Copenhagen - city centre



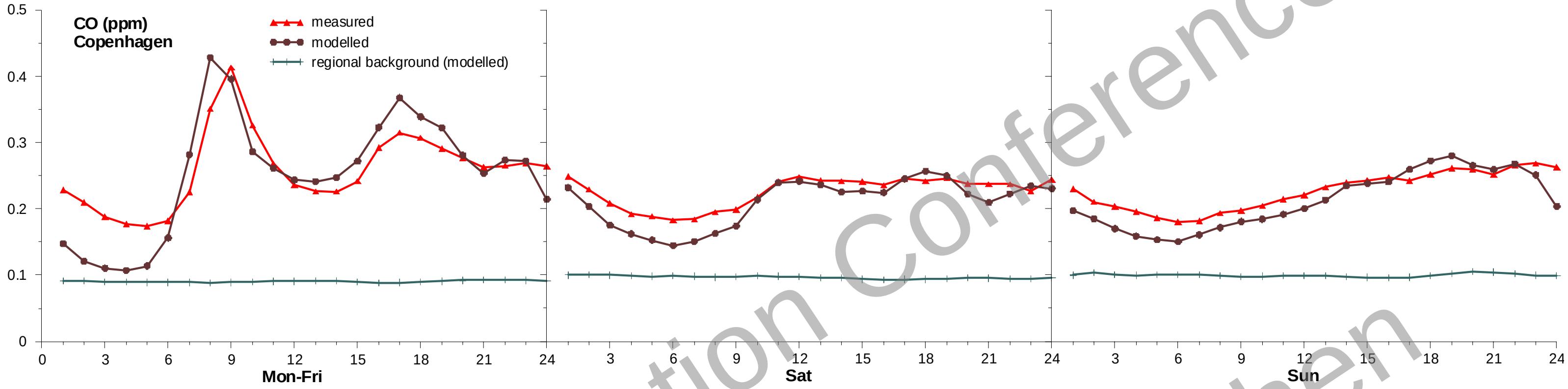
Hourly variation of measured and modelled NO_x concentrations at the urban background station in Copenhagen.



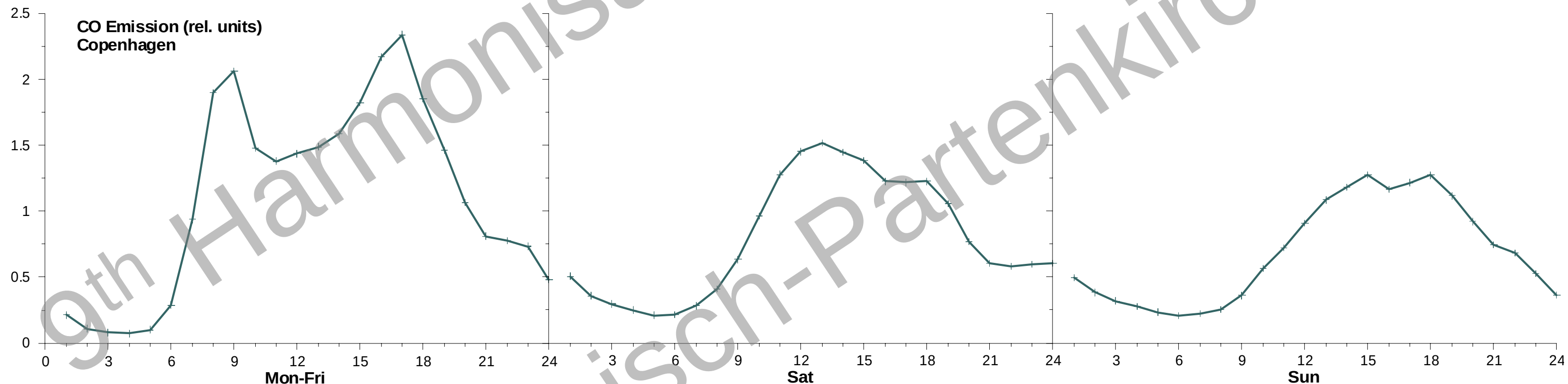
Hourly variation of NO_x emissions in Copenhagen (relative units).



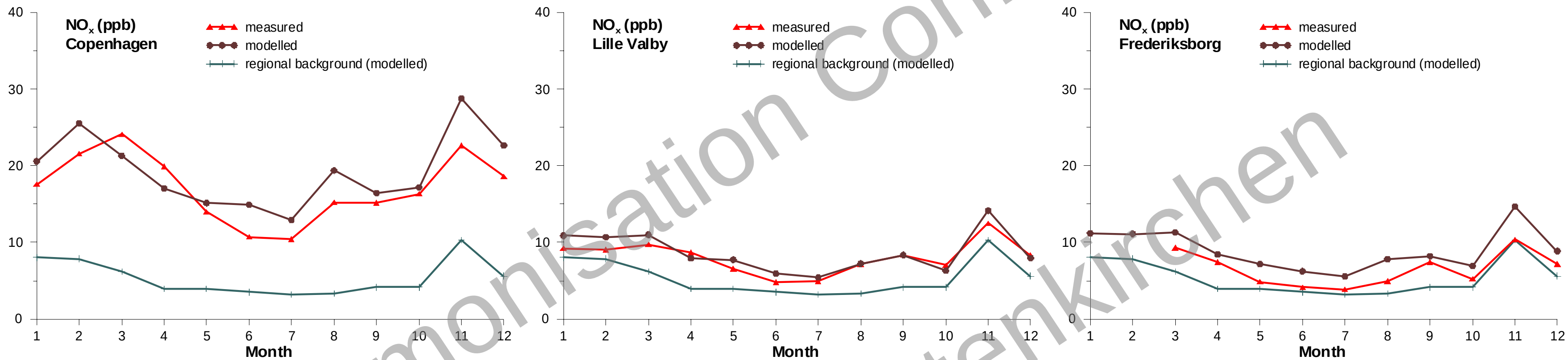
Dilution factor



Hourly variation of measured and modelled CO concentrations at the urban background station in Copenhagen.



Hourly variation of CO emissions in Copenhagen (relative units).



Monthly variation of measured and modelled NO_x concentrations at the stations in the Copenhagen region.

The monthly variation of the modelled concentrations is due to variation in the meteorological conditions only!

There is no seasonal variation in the NOX emissions in the model.

Conclusions

- Modelling of air pollution in cities requires high resolution emission data (1 x 1 km^2 ?)
- Model results should be tested on measurements of primarily emitted pollutants (NO_X, CO ?)
- Appropriate description of the dilution process close to the sources is crucial.
- A simple dispersion model can provide reasonable and useful results for a limited urban area (50 x 50 km^2) without requiring too much CPU-time.

ACKNOWLEDGEMENTS

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