

# Evaluation of Traffic-related Air Pollution Exposure in Sensitive Environments with a Gaussian Model and a Hybrid Eulerian-Gaussian Model



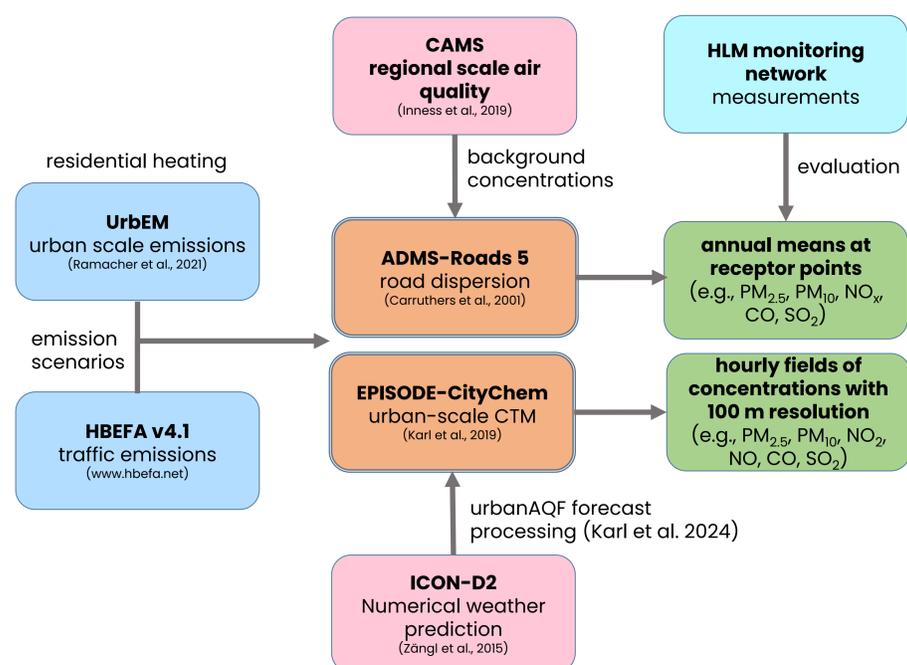
Matthias Karl, Department of Chemistry Transport Modeling, Institute of Coastal Environmental Chemistry, Helmholtz-Zentrum Hereon, Geesthacht, 21502, Germany.

Saba Manzoor, Earth Science and Engineering, Royal School of Mines, Imperial College London, London, SW7 2BP, UK. [matthias.karl@hereon.de](mailto:matthias.karl@hereon.de)

## Traffic-related Air Pollution

Road traffic is a major source of air pollution in European cities, contributing significantly to emissions of nitrogen oxides ( $\text{NO}_x$ ) and primary fine particulate matter ( $\text{PM}_{2.5}$ ), which have serious implications for public health. Many studies have demonstrated that traffic-related particulate pollution efficiently penetrates indoor environments. This study assesses and compares traffic-related air pollution exposure using two dispersion models, ADMS-Roads 5 and EPISODE-CityChem. ADMS-Roads is a Gaussian model optimized for high-resolution modelling along local road networks, while EPISODE-CityChem is a hybrid Eulerian-Gaussian model that captures pollutant transport, chemical transformation, and deposition on a 3-D grid, with embedded near-source dispersion capabilities. The selected inner-city urban area (3.5 km  $\times$  2.8 km) in Hamburg, Germany, includes 376 receptors in sensitive environments, such as schools, hospitals, and nurseries, as well as four air quality monitoring stations.

## Emissions and Dispersion Model setup



## Model validation by comparison with observations

**Table 1:** Comparison of annual means calculated by ADMS ("adms") and EPISODE-CityChem ("epicc") to measurements ("obs") at stations in the city centre of Hamburg.

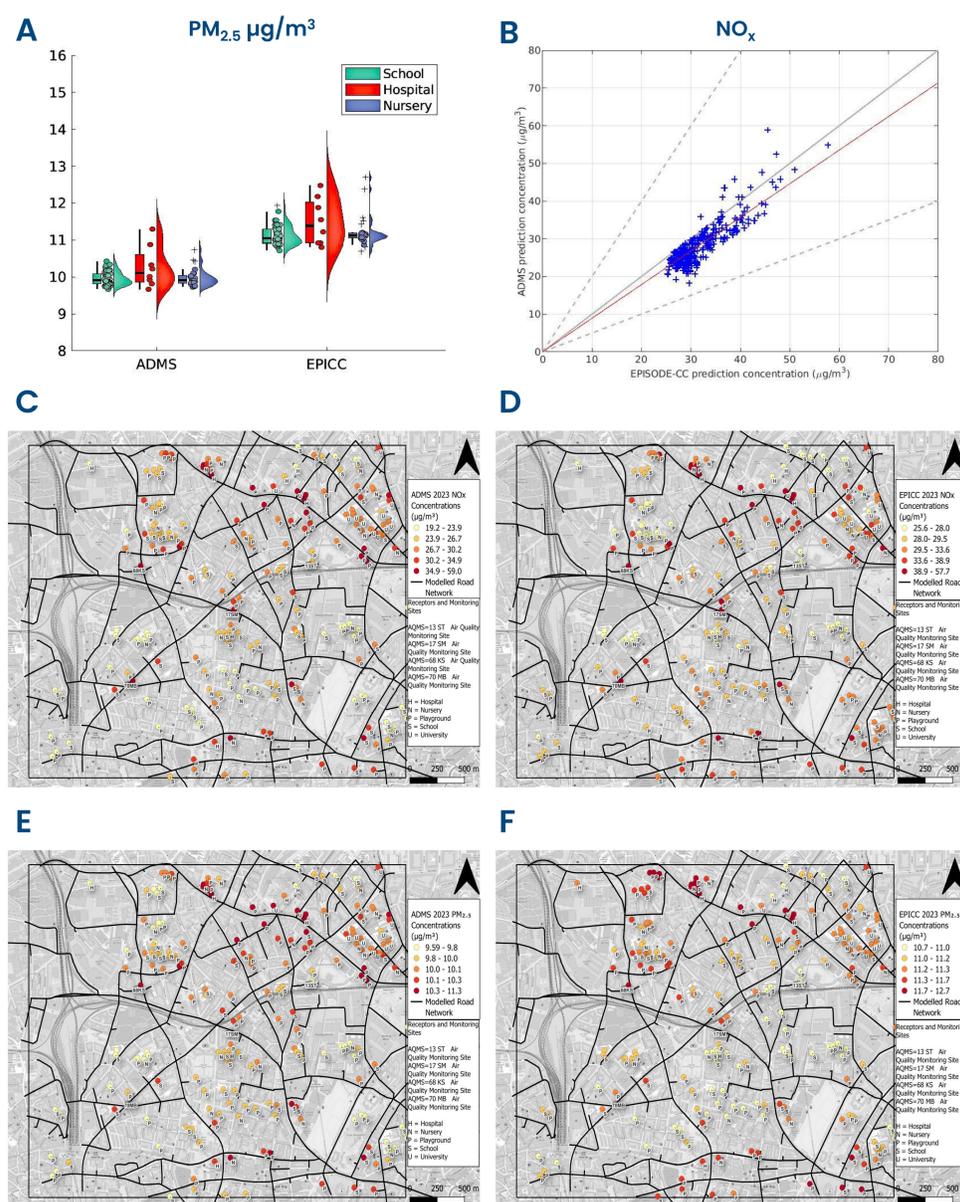
Pollutant and station	Mean (obs) [ $\mu\text{g}/\text{m}^3$ ]	Mean (adms) [ $\mu\text{g}/\text{m}^3$ ]	Mean (epicc) [ $\mu\text{g}/\text{m}^3$ ]	Delta (adms-obs)	Delta (epicc-obs)
<b><math>\text{PM}_{2.5}</math></b>					
13 ST (urban backgr.)	9.25	9.80	10.8	6 %	17 %
68 KS (traffic)	9.47	10.5	12.5	11 %	32 %
<b><math>\text{NO}_x</math></b>					
13 ST (urban backgr.)	20.4	24.4	27.9	19 %	36 %
17 SM (traffic)	50.2	52.6	47.2	5 %	-6 %
70 MB (traffic)	47.5	55.0	57.7	16 %	21 %
64 KS (traffic)	51.8	43.8	47.1	-15 %	-9 %

### References

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## Exposure in Sensitive Environments

**Figure 1:** Annual mean  $\text{PM}_{2.5}$  and  $\text{NO}_x$  concentrations: **A)**  $\text{PM}_{2.5}$  distributions for schools, hospitals, and nurseries, **B)** scatterplot of  $\text{NO}_x$  model results from ADMS vs. EPISODE-CC (N=380), maps of annual mean concentrations at inner-city receptors showing **C)**  $\text{NO}_x$  from ADMS, **D)**  $\text{NO}_x$  from EPISODE-CC, **E)**  $\text{PM}_{2.5}$  from ADMS, and **F)**  $\text{PM}_{2.5}$  from EPISODE-CC.



## Conclusions and Outlook

- Comparison with measurements confirms the usability of the model results for exposure assessments.
- EPISODE-CityChem results consistently higher  $\text{NO}_x$  (12 %) and  $\text{PM}_{2.5}$  (13 %) concentrations than ADMS. Modelled  $\text{NO}_2$  from EPISODE-CC is on average  $26 \pm 2 \mu\text{g}/\text{m}^3$  in the sensitive environments.
- In sensitive environments,  $\text{PM}_{2.5}$  is on average slightly above the limit value ( $10 \mu\text{g}/\text{m}^3$ ), while  $\text{PM}_{10}$  is below the limit value ( $20 \mu\text{g}/\text{m}^3$ ), of the revised EU ambient air quality directive (AAQD 2024/2881).
- Hospitals experience the highest exposure to particulate matter, as they are frequently situated near major streets.
- Scenario simulations are planned in accordance with the Hamburg mobility strategy for the year 2030 (modal shift, electromobility, etc.).

### Acknowledgements

This project uses data from urbanAQF: <https://hcdc.hereon.de/urbanaqf>

