

**23rd International Conference on
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EXTENDED ABSTRACT

***Application of the lagrangian model LASAT in complex urban area for exposure assessment
in the vicinity of medical and industrial facilities. Modell comparison and validation with
wind tunnel measurements. (Project EXPO-URB, Part 1)***

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Abstract: The research project EXPO-URB aims to investigate the extent, to which the lagrangian model ARTM, or the model chain typically consisting of a wind field model and the dispersion model itself, is suitable for exposure modelling in the case of potentially releases in complex urban environments. The model, which used since 2021 for the calculation of radiation exposure by the Federal Office for Radiation Protection in Germany (BfS), has so far only been evaluated for emissions of radioactive substances from nuclear power plants, but not for use in urban built-up areas. Another aim was the creating of a harmonised data set with wind tunnel measuring data, which can be widely apply for model validation. For the purpose of the study the lagrange model LASAT, coupled with the prognostic model MISKAM, were applied for a set of reference scenarios across several complex urban areas. All model results were compared with the other simulations results, conducted in the project team and validated with wind tunnel measurements. The influence of different wind direction or building configurations was analysed. Key problems in coping with dispersion modelling in urban area were discussed. Each model was developed with its strength and limitations and the choice of the proper model approach depends on the particulate demands. Since the input requirements differ from model to model, a high degree of caution in the interpretation of the model results is required.

This study was conducted by GeoSphere Austria (former Central Institute for Meteorology and Geodynamics, ZAMG) with project leader University of Hamburg and in cooperation with TU Graz and ISAC-CNR. The project was funded by the Federal Office for Radiation Protection in Germany (Bundesamt für Strahlenschutz, BfS).

Keywords: *Lagrangian particle models, Wind Tunnel experiments, Release in Built Environment, Model Intercomparison*

Introduction

The research project EXPO-URB aims to assess the suitability of the Lagrangian model ARTM, as well as the commonly used model chain comprising a wind field model and a dispersion model, for exposure modelling in cases of potential releases in complex urban environments. The model, which has been used since 2021 for calculating radiation exposure by the Federal Office for Radiation Protection in Germany (BfS), has so far only been evaluated for radioactive emissions from nuclear power plants, and not within densely built-up urban areas.

Another key objective of the project was to create a harmonised dataset based on wind tunnel measurements, which can be widely used for model validation. For this purpose, the Lagrangian dispersion model LASAT, in combination with the prognostic wind field model MISKAM, was applied to a set of reference scenarios in several complex urban settings. The modelling results were compared both with simulations conducted by other project team members and with wind tunnel measurement data for validation. The study analysed the influence of varying wind directions and different building configurations of the simulated concentrations. Key challenges related to dispersion modelling in urban environments were identified and discussed. Each model has its own strengths and limitations, and the selection of an appropriate modelling approach depends on the specific requirements of the application. Given the differences in input data needs across models, careful interpretation of modelling results is essential.

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MISKAM –LASAT coupling

The lagrangian particle models **LASAT** (Lagrangian Simulation of Aerosol Transport), version 3.4 (Janicke Consulting, 2019), simulate pollutant plumes as clouds composed of numerous small particles, with each particle representing a defined mass of the pollutant. The transport of each individual particle is calculated by taking into account both spatial and temporal variations in wind conditions. Turbulent diffusion is modelled using stochastic (random) processes, consistent with the principles of lagrangian simulation. LASAT complies with the VDI Guideline 3945 Part 3 (Particle Model) and serves as the basis for the regulatory dispersion model AUSTAL2000, which is specified in the German Technical Instructions on Air Quality Control (TA Luft, 2002). The microscale flow and dispersion model **MISKAM** (Eichhorn, 1989; Eichhorn and Kniffka, 2010) is a physical model designed to calculate wind fields and pollutant concentration distributions in areas with complex building structures, typically on spatial scales of a few hundred meters. The flow simulation in MISKAM is based on the full set of three-dimensional momentum equations. Turbulent momentum transport is accounted for using horizontal and vertical exchange coefficients. This enables the model to realistically represent small-scale wind fields.

Model input configuration

In the present case, the flow fields were calculated using MISKAM and were provided as a wind field library for the dispersion model LASAT. The model configurations are summarized in Table 1 and Table 2 for the coarse and fine resolution of the domain, respectively. The configuration for the source is presented in Table 3.

Model parameter (coarse resolution)	Settings
model version	MISKAM 6.0.3/LASAT -3.4.24-64l
model domain	1430m x 1430m x 200m
horizontal resolution	5m x 5m
vertical resolution	3m up to 70m /after 70m - stretched
number of the grid cells	286, 286, 35
reference points	xmin = -715, ymin = -715
highest building in the domain	49.2m above ground
minimal distance between model border and buildings	10 grid cells
simulated time (hours/days/year)	15 hours
z_0	0.6m
reference wind	logarithmic profile
location of reference wind measurement	600 , -600
reference wind height	100m
reference wind speed	10m/s
stability	neutral

Table 1: Model configuration for the coarse resolution as specified in the EXPO-URB project.

Model parameter (fine resolution)	Settings
model version	MISKAM 6.0.3/LASAT -3.4.24-64l
model domain	800m x 1200m x 200m
horizontal resolution	2m x 2 m
vertical resolution	3m up to 70m /after 70m - stretched
number of the grid cells	400, 600, 35
reference points	xmin = -400, ymin = -600
highest building in the domain	49.2m above ground
minimal distance between model border and buildings	10 grid cells
simulated time (hours/days/year)	15 hours
z_0	0.6m
reference wind	logarithmic profile
location of reference wind measurement	-290 , 450
reference wind height	100m
reference wind speed	10m/s
stability	neutral

Table 2: Model configuration for the fine resolution as specified in the EXPO-URB project.

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Source parameter	Settings
coordinates	N: 430.4 m E: 2.4 m
height	20m
diameter of the source	2m
shape of the source	circle
height of the source above building	2m above flat roof level
stacks: yes/no	yes
emission rate	2g/s
exit temperature	20°C

Table 3: Source model configuration applied in the dispersion model LASAT.

The Figure 1 and 3 display the wind fields, calculated with the model MISKAM and the corresponding dispersion simulation, processed with LASAT. Both evaluations are done for the ground layer, which is chosen to represent the pedestrian level. As expected, the distribution of concentration reaches its maximum near the source and is decreasing with respect to the distance. The models were applied to a set of reference scenarios featuring variations of the wind direction ($\pm 10^\circ$) and building configurations but keeping a constant simulation time of 15 hours. Ongoing simulations will focus on continuous exposure scenarios, resulting in estimations of annual critical values.

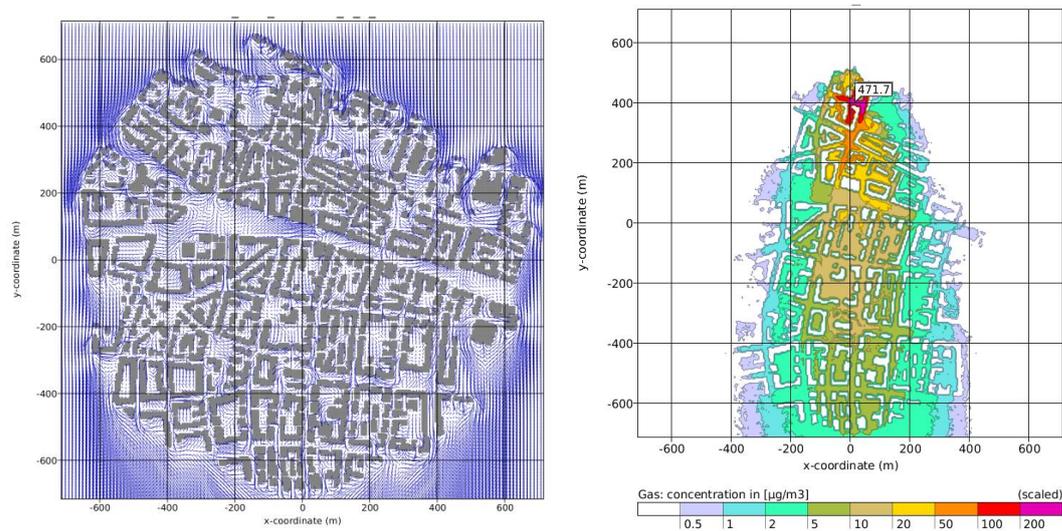


Figure 1: The wind field calculated with MISKAM (coarse resolution, wind direction 360°) for the vertical level Z from 0m to 3m (left) and the dispersion calculations conducted with LASAT for the same level (right).

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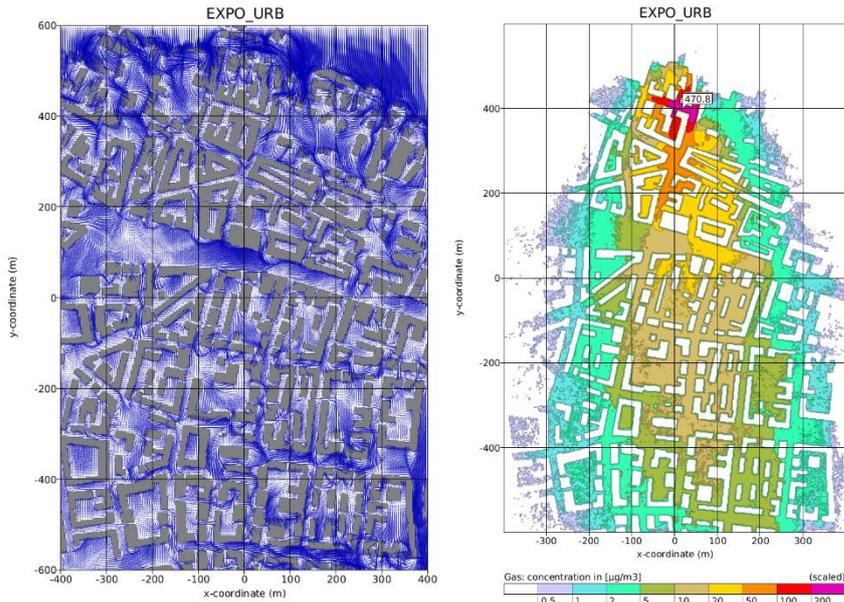


Figure 2: The wind field calculated with MISKAM (fine resolution, wind direction 360°) for the vertical level Z from 0m to 3m (left) and the dispersion calculations conducted with LASAT for the same level (right).

The influence of the different building geometries of the calculated concentrations is shown on Figure 3. The variation of the maximum concentrations among the three geometries is about 30 µg/m³.

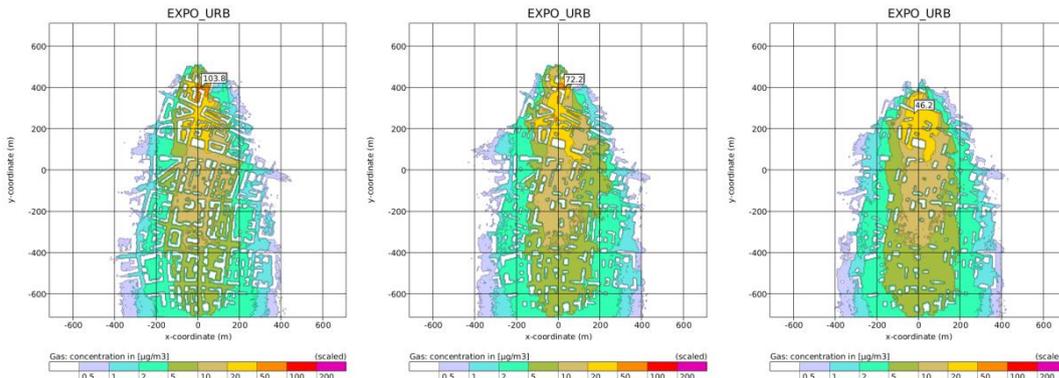


Figure 3: Comparison of the influence in dispersion, with respect to different buildings geometries (dense, medium, low) for the vertical layer 0 to 3 m.



Figure 4: Different buildings geometries (dense, medium, low) as applied in the models.

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Conclusions

The presented project investigates the applicability of the Lagrangian dispersion model in a commonly used model chain—comprising the prognostic wind field model MISKAM and the dispersion model LASAT—for exposure modelling in complex urban environments during potential pollutant releases. A key goal was the development of a harmonized, high-quality dataset based on wind tunnel measurements, designed to support model validation across the research community. The models were applied to a set of reference scenarios featuring varying wind directions and urban configurations. Results were compared with both independent simulations and experimental data to assess model performance. Findings highlight the strengths and limitations of the tested approaches under realistic urban conditions, offering guidance for future applications in risk assessment and urban planning.

By examining the several tested models performance under the predefined reference release scenarios, the study aims to bridge the gap between established methods for simulations at rural and industrial establishments (accidental releases) and the increasing need for reliable urban exposure assessments.

References

- Baumann-Stanzer, K., B. Leitl, S. Trini-Castelli, Millies, M., Rau, G. and all COST ES1006 members (2014): Local-scale modelling of accidental releases in built environments – selected results of the „Michelstadt“ model evaluation exercise in COST Action ES1006. Proc. 9th Int. Conf. on Air Quality – Science and Application, Garmisch-Partenkirchen, 24 – 28 March 2014, p. 106.
- Eichhorn, J. und A. Kniffka, 2010: The numerical flow model MISKAM: State of development and evaluation of the basic version. Meteorologische Zeitschrift, Vol. 19, No. 1, 81-90.
- Eichhorn, J., 1989: Entwicklung und Anwendung eines dreidimensionalen mikroskaligen Stadtklima - Modells. PhD Thesis, Univ. Mainz.
- Janicke Consulting (2019): Dispersion Model LASAT Version 3.4 Reference book.
- Janicke, L. et al. (2004): Development of the Odour Dispersion Model AUSTAL2000G in Germany. Environmental Odour Management. VDI-Berichte 1850.
- TA-Luft (2002): Aktuelle Immissionsschutzrechtliche Anforderungen an den Anlagenbetreiber. Dr. Dieter Jost. WEKA Fachverlag für technische Führungskräfte GmbH.; Stand Oktober 2002.
- VDI 3945 Blatt 3 (09/2000) „Umweltmeteorologie. Atmosphärische Ausbreitungsmodelle. Partikelmodell“, Kommission Reinhaltung der Luft (KRdL) im VDI und DIN – Normenausschuss.