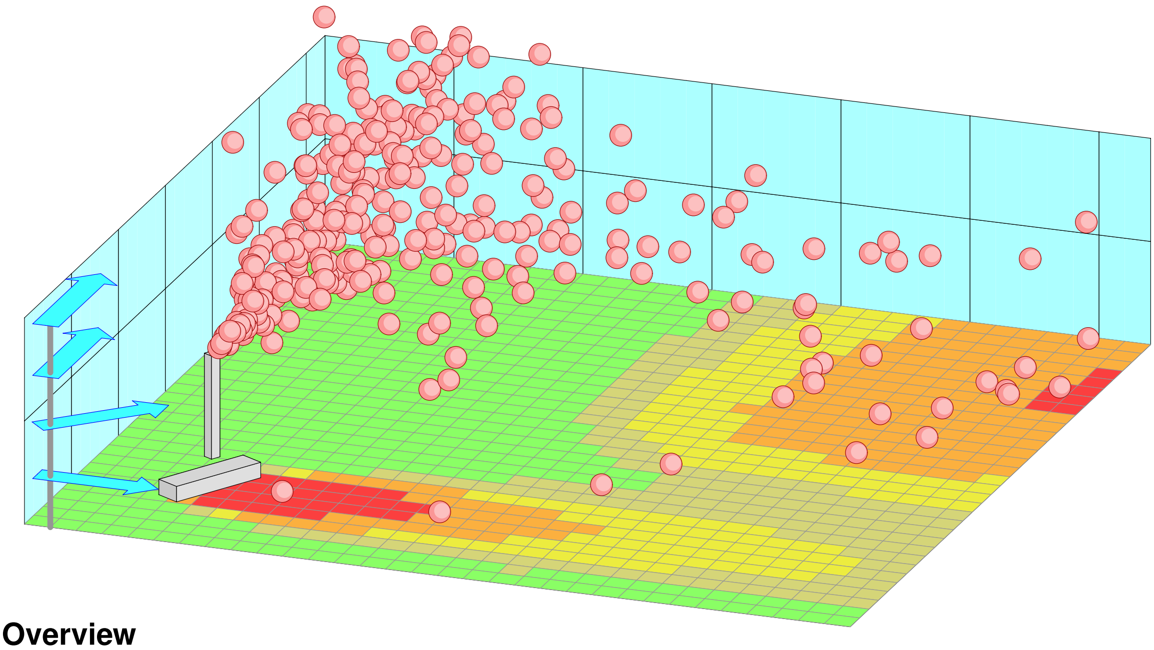
Janicke Consulting
Environmental Physics

LASAT

A program system for the calculation of pollutant dispersion in the atmosphere



Overview

The dispersion model LASAT (Lagrangian Simulation of Aerosol Transport) computes the transport of trace substances in the atmosphere. It simulates the dispersion and the transport of a representative sample of tracer particles utilizing a random walk process (Lagrangian simulation) Some advantages over other simulation methods are:

- In the near field of sources (up to several 100 m), the Lagrangian technique allows for a more accurate description of the dispersion in the atmosphere as compared to models based on the classical equation of diffusion.
- The dispersion process is not subject to numerical artefacts that are usually inherent to finite difference methods. For example, a point source is truly modelled as a point source.
- Complex source systems such as large road nets can be handled more economically than compared to plume models by choosing the number of emitted simulation particles proportional to the local source density.
- By choosing an appropriate number of particles, the user can give preference either to short computation time or to high computational accuracy.

LASAT is a professional tool for the assessment of dispersion situations. It is based on a research model which was developed in 1980 and tested in various research projects. Since 1990 LASAT is available as a software package. Since then it has been regularly applied by national authorities, consulting bureaus, and industrial companies.

LASAT served as basis for the development of the dispersion model AUSTAL2000, the official reference model of the German regulation 'TA Luft' (Technical Instruction on Air Quality Control). LASAT offers a wider application range and allows to study problems that reach beyond the scope of 'TA Luft'.

The continuous improvement and adaptation to requirements of practical demands make LASAT a robust tool with a broad range of applications.

The figure shows a complex source configuration (a stack modelled as a point source and a shed modelled as an area source) exposed to a sheared wind field: near the ground the wind blows from west, in higher layers from south (blue arrows). Accordingly, the near-ground pollutant concentration caused by the stack is located north-east while the one caused by the shed extends to the east.

Features of LASAT 3.4

The dispersion model LASAT computes the transport of passive trace substances in the lower atmosphere (up to heights of about 2000 m) on a local and regional scale (up to distances of about 200 km). LASAT is a Lagrangian particle model in compliance with the German guideline VDI 3945 Part 3. In such a model type, the dispersion of trace substances in the atmosphere is simulated utilizing a random walk process on a computer. The following physical processes, including time dependencies, are simulated:

- transport by the mean wind field,
- dispersion in the atmosphere,
- sedimentation of heavy aerosols,
- deposition on the ground (dry deposition),
- washout of trace substances by rain and wet deposition,
- first order chemical reactions.

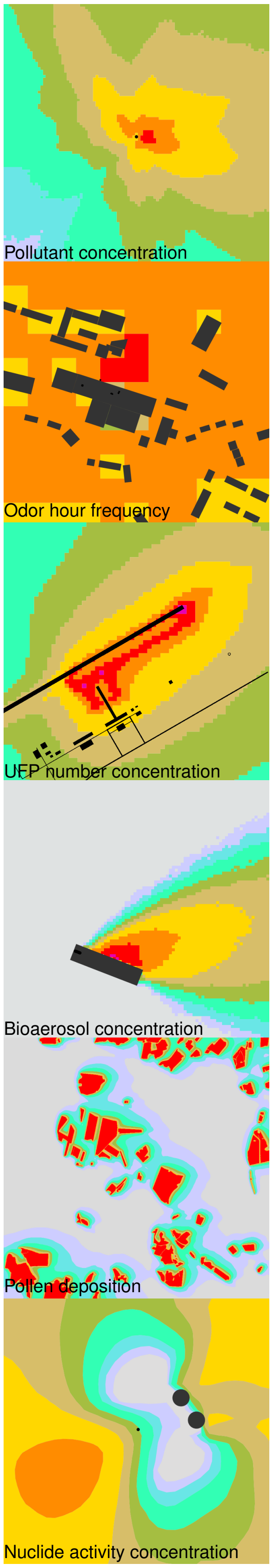
Thermal plume rise is covered parametrically based on the German guidelines VDI 3782 Part 3 (stacks) and VDI 3784 Part 2 (cooling towers), or utilizing the three-dimensional plume rise model PLURIS. Cloud radiation (gamma submersion) of radioactive matter is calculated by a post-processor. For odorants, odor hour frequencies can be determined, also for rated odorant components.

In flat and homogeneous terrain, the time dependent meteorological parameters are described by means of a one-dimensional boundary layer model, optionally according to guideline VDI 3783 Part 8. It is based on simple parameters that characterize the weather situation. In addition, turbulence data from an ultrasonic anemometer or vertical profiles supplied by a SODAR equipment can be applied. The three-dimensional boundary layer profile can also be provided by other models.

A diagnostic wind field model is integrated in the meteorological preprocessor and allows to carry out dispersion calculations in complex terrain or in the presence of buildings. Alternatively, three-dimensional wind fields and turbulence fields from other meteorological models can be used which may take into account in more detail the influence of built-up areas and/or structured terrain.

Emission sources of any number can be defined in form of point, line, area, volume, or grid sources. Most of the parameters necessary for the dispersion simulation, especially emission rates, source locations, exchange rates, and deposition rates, can be specified as independent time series.

The result of the dispersion simulation is the three-dimensional concentration field of the emitted trace substances averaged over successive time intervals, and the mass flow density of deposition into the ground. The horizontal spatial resolution amounts typically to about 1 % to 3 % of the total area of calculation. The vertical grid spacing can be freely set.



The sequence of figures shows in a schematic form different application areas of LASAT. Each figure shows the near ground pollution, dark shapes denote emission sources or buildings that act as flow obstacles. The figures are based on actual dispersion calculations with LASAT.

A sampling error is inherent to particle simulations. It can be reduced by increasing the number of particles. An automatic estimate of the sampling error is made in course of the simulation.

In addition to the complete three-dimensional concentration field, time series of the concentration and deposition flows at specified monitor points can be obtained.

If meteorological data is provided in form of a time series, long-time averages, percentiles, and excess probabilities – e.g. according to EU directives – can be computed. Alternative to a time series, a dispersion class statistics can be used.

In the near field of sources, the dispersion calculation can be carried out with an increased spatial resolution. This is achieved by a combination of several spatial grids with mesh widths changing from grid to grid by a factor of two.

LASAT is verified according to guideline VDI 3945 Part 3 and has been validated on the basis of various experimental data sets.

LASAT can be used in conformance with TA Luft (2002 and draft 2018), yielding results identical to AUSTAL2000 and AUSTAL. The required parameter settings and examples are explained in the program manual.

The program system

The computer program is written in ANSI-C and JAVA and consists of several components:

Boundary layer model:
It creates the meteorological input fields, either as a one-dimensional boundary layer based on typical boundary layer parameters and/or given vertical profiles, or in form of three-dimensional fields derived by a diagnostic wind field model, optionally accounting for pre-defined wind fields.

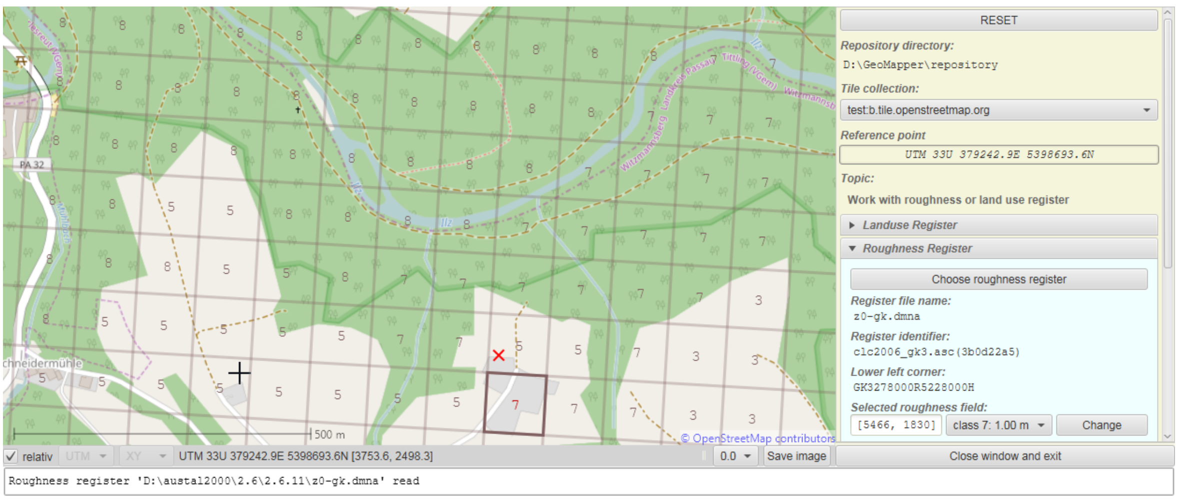
Dispersion model:
It calculates the three-dimensional concentration field and the distribution of dry and wet deposition fluxes. The frequency distribution of concentration values is stored for a later calculation of percentiles or excess probabilities. A simulation run can be interrupted and continued at a later time.

Pre- and post-processors:
A variety of auxiliary programs are provided for various purposes. Newer ones are bundles in the LASAT tool set *LTools* with unified, interactive user interface. The tasks include: Display and usage of OpenStreetMap cards, evaluation of registers of roughness and land use, check of input data, conversion of external file formats, interactive definition of object locations and shapes, result evaluation according to EU directives, interactive result visualization.

Hardware requirements

The standard program package is provided for Windows (7 to 10, 64-bit) and for Linux (64-bit). A DVD drive for the installation and a USB port for the licence key are required. At least 2 GB RAM and 10 GB free hard disk space are recommended.

The dispersion program and the wind field program support multi-threading and use either all or a specified number of processor cores.



Display of a roughness register in a OpenStreetMap card with the tool GeoMapper. The maps are automatically downloaded from the Internet and stored locally for further use. They are worldwide available and provided in 18 zoom levels.

Formats, Documentation

All input and output data is provided in form of formatted text files.

Formats, programs, and underlying models are described in the reference book (300 pages) and further explained at hand of examples in the working book (60 pages).

Language, GUI

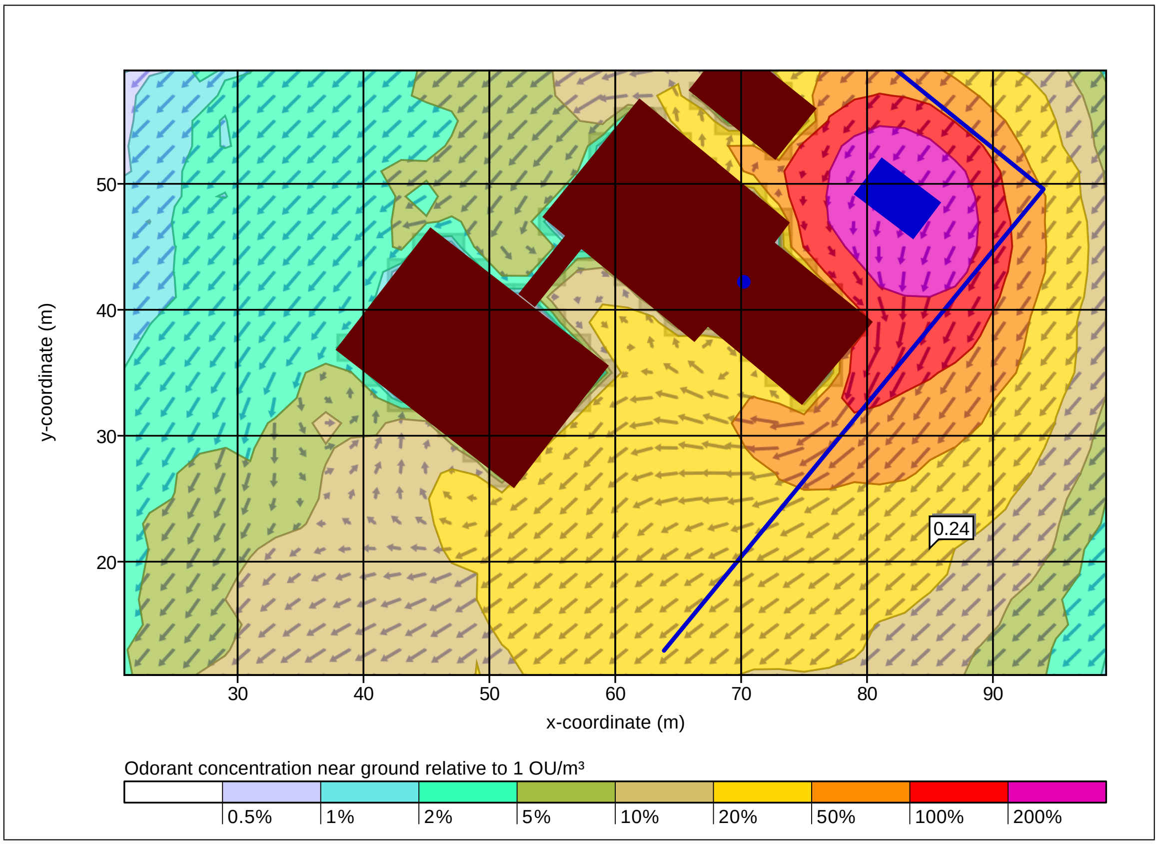
The program system including documentation, text output, and parameter names is in English.

Interactive programs (among others: map display, input check, definition of object shapes, result evaluation, result visualization) are provided with a graphical user interface (English and German).

The interactive programs apply a local JAVA Runtime Environment (JRE) which is part of the distribution. The core programs run in a console window (DOS under Windows).

Demo Version

A demo version can be provided free of charge. It is identical to the full program package but does not include a license. It allows to re-calculate the examples of the distribution and to modify them to a limited extent.



The figure shows the concentration near ground of an odorant that is emitted from a trench, a silage, and a stack (blue outlines). The integrated diagnostic wind field model has been used to account for the effects of the buildings (brown outlines). The calculated flow field is depicted as background map and the concentration value at a selected location is indicated by the small flag. The image was saved as PDF file with the post-processor IBJdis and included in this document without modification.

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All depicted diagrams except for page 1 are original outputs created with the LASAT *software package.*