Product specification of program package LASAT 3.4

Although some of the following specifications represent upper limits, like e.g. the maximum number of sources, they may be exceeded in many cases depending on the computer configuration and the combination of specifications being used.

1. **Hardware requirements, performance**

   (a) Preferred platform PC with DVD drive and a free USB slot for the licence key. At least 2 GB RAM and 10 GB free hard disk space are recommended.

   (b) Supported operating systems Windows (7 to 10, 64-bit) and Linux (64-bit, tested on Suse and Ubuntu).

   (c) Support of multi-threading (*Lasat*, *Lprwnd*, *Lopgam*), optionally specification of the number of threads.

2. **Language, formats**

   (a) Documentation, parameter names, and error messages in English.

   (b) Access of core programs in a command line window, interactive programs provide a graphical user interface (English/German).

   (c) Input and output data provided as text files (optionally compressed and binary data parts) with fully documented contents and formats (DEF and DMN).

3. **Boundary layer model *Lprprf***

   The boundary layer model (internal module of *Lasat* and stand-alone program) provides the meteorological profile functions on the vertical grid (wind speed and direction, fluctuations of wind velocity, exchange coefficients).

   (a) In the simplest case specification of wind speed and direction at one anemometer height together with the atmospheric stability (Obukhov length or stability class according to Klug/Manier).

   (b) Specification of profile values at up to 20 anemometer heights. Linear interpolation between these heights, beyond extrapolation with the theoretical profile functions.

   (c) Definition of profile values, Obukhov length, stability class, mixing layer height, and friction velocity as time series (at maximum 9999 successive intervals).

   (d) For complex terrain incorporation of a diagnostic wind field model (see *Lprwnd*).

   (e) Optionally meteorological profiles of the German regulation 'TA Luft' (2002 and 2017).

   (f) Specification of a precipitation rate, optionally space-dependent.

4. **Wind field program *Lprwnd***

   The diagnostic wind field model (internal module of *Lprprf* and stand-alone program) calculates a three-dimensional, divergence-free wind field on the basis of the given profiles and the specification of terrain and buildings.

   (a) Integration of complex terrain (terrain profile and/or buildings) in the boundary conditions of the flow field.

   (b) Modelling of the flow around buildings under consideration of recirculation and enhanced diffusion at the leeside.

   (c) Collection of wind fields in a library, from where they are selected as required.

   (d) Import of wind fields from other program systems.

5. **Dispersion program *Lasat***

   (a) Area of calculation

      i. Extent: local to regional range (up to source distances of about 200 km), atmospheric boundary layer (up to a height of about 2000 m).

      ii. Grid: Horizontally: equally spaced meshes with a uniform width of typically 5 m to 10 km. Maximum number of meshes in each direction 300. Vertically: division into at most 200 arbitrary intervals.

      iii. Nesting: Up to 9 nested grids. Change of mesh width from grid to grid by a factor of 2.

      iv. Boundary conditions: Horizontally open or periodic, at the top open or closed.

   (b) Terrain

      i. Characterisation by a roughness length and a displacement height.

      ii. Specification of a terrain profile.

   (c) Buildings

      i. Definition in form of cubes, circular towers, and polygons of constant height, up to 200 buildings. Alternatively definition by a raster file. Building top parallel to the terrain surface.

      ii. Shapes internally resolved on the calculation grid.

      iii. With nested grids, consideration on the grid with the smallest mesh size.

   (d) Sources

      i. Definition of point, line, area, volume, and 3-dimensional grid sources. Up to 1000 sources.

      ii. Parametric treatment of plume rise according to the German guideline VDI 3782 Part 3 (stacks), or VDI 3784 Part 2 (cooling towers), PLURIS, or explicit specification of a directed exit velocity and velocity fluctuations together with their decay time.

   (e) Trace substances

      i. Bundling of trace substances (at most 60) into groups (at most 5).

      ii. Definition of a gravitational settling velocity for every group. For gravitational settling of dust, alternatively definition of a continuous size spectrum.

   iii. Definition of emission rate, deposition velocity (dry deposition), washout rate (wet deposition), and chemical reactions (first order conversion) for every substance.

   iv. Definition of spatially varying deposition velocities.

   v. Definition of odorants and rated components according to the German regulation GIRL.

(f) Time series

Time-dependent specification of meteorological parameters and parameters describing source and substance properties in form of time series (at most 9999 successive intervals), optionally distributed over several independent files.

   i. Free choice of the averaging interval for input and output data, typically between a minute and a year.

(g) Program control

   i. Control of calculation time and statistical error by the number of applied simulation particles.

   ii. Program interruption and continuation at a later time.

   iii. Output of information on the program run and the total emitted mass per substance into a log file.

(h) Results

   i. Concentrations and dry and wet deposition fluxes averaged over each grid cell for a series of successive time intervals. For odorants output of the odor hour frequency instead of the concentration.

   ii. Time series of concentration (e.g. hourly means) at given monitor points.

   iii. Maximum concentration values or concentration histograms for the calculation of quantiles.

   iv. Estimation of the statistical error for every output value.

6. **Utility programs**

(a) *LASAT tools* (batch mode and interactive):

   i. Display and application of OpenStreetMap cards downloaded from the Internet (for usage see www.openstreetmap.org/copyright).

   ii. Inspection and correction of roughness registers.

   iii. Calculation of average roughness lengths.

   iv. Check of LASAT definition files.

   v. Check and evaluation of time series.

   vi. Re-formatting, extraction and evaluation of result files.

   vii. Evaluation of rated odorants.

   viii. Preparation of result reports similar to AUSTAL2000.

   ix. Evaluation of data files from supersonic anemometers.

(b) Interactive definition of source and building shapes from a site map.

(c) Interactive result visualization:

   i. Tabulated view of two-dimensional layers.

   ii. Graphical view of horizontal layers of concentration and wind fields (e.g. isolines, superposition of value matrix, background map, terrain profile, source and building contours).

   iii. Output as PNG or PDF file.

(d) Conversion of meteorological time series and dispersion class statistics to LASAT time series.

(e) Calculation of cloud radiation of radioactive substances.

7. **Example calculations**

The program package includes over 30 example calculations covering typical applications from simple to complex.

8. **Calculations in conformance with TA Luft**

The reference book lists the parameter settings required for calculations in conformance with TA Luft (2002 and 2017).

9. **Verification**

The model is set up and verified in strict conformance with the German guideline VDI 3945 Part 3. The verification tests can be re-run by the user.

10. **Documentation**

The reference book (about 300 pages) describes the usage of the programs, the structure and format of input and output files, the implemented model approaches, and the verification tests.

The working book (about 60 pages) describes the installation of the program system and provides an introduction at hand of a step-by-step description of example applications.

11. **Demo version**

Without valid licence, the programs operate in demo mode with the possibility to re-run example calculations and verification tests. A demo version can be provided free of charge.

12. **Support**

An introduction on site, support via email and phone, and preparation of individual auxiliary programs can be offered on demand.

13. **Purchase**

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