EXPERIENCES WITH THE GERMAN REGULATORY MODEL AUSTAL2000 IN GERMANY AND IN OTHER COUNTRIES IN THE FRAMEWORK OF EU TWINNING PROJECTS

Wolfgang J. Müller[1] *and Ulf Janicke*[2]
[1]former Lower Saxony State Agency for Ecology, Laatzen, Germany
[2]Janicke Consulting, Überlingen, Germany

INTRODUCTION

Several EU Twinning "Air Quality" Projects (with Poland, Turkey, Romania, and Bulgaria) have been addressing dispersion modelling. Main interests were regulatory purposes for industrial and agricultural sources, both for permits and assessments.

As a contribution from Germany, the dispersion modelling system AUSTAL2000 was introduced. Although application of the dispersion model was usually straightforward, quality assurance by an organized step-by-step check of the input data, the model usage, and the according documentation turned out to be essential to identify deficiencies in information and background knowledge of the involved persons. These tasks turned out to be particularly demanding for scenarios that become of increasing interest: near-ground sources (i.e. odour frequency and ammonia in the vicinity of animal farms) or diffusive sources (sewage plants or village areas).

Introduction of AUSTAL2000 in the framework of Twinning Projects usually followed the sequence COPY – ADJUST – CALCULATE, which is explained in some more detail further below.

AUSTAL2000 produces a log file that allows retracing a dispersion calculation and applied parameter settings. Preparation of a dispersion calculation and quality assurance can be supported by the provision of a detailed check list. Such a list is presently being prepared in Germany in form of a VDI guideline. It allows checking and controlling the completeness and plausibility of data sources, input data, assumptions, and documentation. Experiences have shown that the analytic methods applied in the measurements of emission and meteorology must be included, too.

DISPERSION MODELLING SYSTEM AUSTAL2000

AUSTAL2000 is a Lagrangian particle model in compliance with the German guideline VDI 3945 Part 3 (2000). This model type is not based on the advection diffusion equation but simulates the trajectories of a sample of particles (see e.g. *Janicke L.*, 1983, 2000, 2002). From these trajectories the values of concentration and deposition are derived. The model contains no calibration parameters but relies solely on meteorological parameters that can be determined without dispersion experiments.

AUSTAL2000 was developed on behalf of the German Federal Environmental Agency (UBA). Details can be found in *Janicke L. and U. Janicke* (2002). It is the official reference model in Germany that implements all specifications given in Appendix 3 of the German Regulation on Air Quality Control (*TA Luft*, 2002). As such, AUSTAL2000 has been widely applied over the last years as a standard tool for air quality assessments according to *TA Luft*.

AUSTAL2000 implements the meteorological profiles of guideline VDI 3783 Part 8 (2002) and the plume rise models of guidelines VDI 3782 Part 3 (1985) and VDI 3784 Part 2 (1990) for stacks and cooling towers, respectively.

STEP COPY

AUSTAL2000 is a public program system that can be downloaded free of charge (including GNU-licensed source code, executables, documentation, and examples) in the Internet (http://www.austal2000.de). Executable versions both for Windows and Linux are provided. Hence, access to the system is straightforward.

STEP ADJUST

Language

In the twinning projects, some problem was posed by the language, as the present version is in German. Essential parts of the documentation (as well as of the underlying *TA Luft*) were usually translated to local language right to the beginning of the project. Furthermore, in the current version (2.3) all language-specific program strings are located in separate plain text files. Hence, by a translation of these files to local language and recompilation of the programs, the creation of a local program version is straightforward.

In this context it was of advantage that central specifications of the *TA Luft* rely on VDI guidelines (see references) which are bi-lingual (German and English).

Data format conversions

The format of external data files as for meteorology, terrain profiles, and land-use data bases is documented in detail. Data format conversions, either by hand or with the help of small pre-processor programs, are also straightforward.

Meteorology

One of the main problems turned out to be the availability or preparation of suitable meteorological data. AUSTAL2000 requires either a time series with hourly means of wind velocity, wind direction, and stability measure (stability class according to the German classification scheme Klug/Manier or the Monin-Obukhov length) or a dispersion class statistics; this is a list with the long-time frequency distribution (typically an average over 10 years) of meteorological situations categorized by stability class (6 groups), wind direction (10-degree sectors), and wind velocity (9 groups) according to guideline VDI 3782 Part 1 (2001).

Provision of a dispersion class statistics was often more feasible as simplifications were possible by applying for example only a reduced number of stability or velocity groups. In some cases, the installation of meteorological measurement devices was pursued right to the beginning of a project (*Müller, W.J.*, 2002).

AUSTAL2000 input file

The input file for AUSTAL2000 is a simple text file that can be created and edited with any text editor. Figure 1 shows an example. Names of required external files like the one with the dispersion class statistics are also specified here.

As AUSTAL2000 is a realisation of the standards and specifications of the *TA Luft*, only a small set of parameter specifications (and thus background knowledge) is required to start with.

```
---------------------------------------------------------------------------
- input data file austal2000.txt
- (a comment line starts with "-", a comment in a line with "'")
-
ti  "Screening001 Odor"     ' title of the project
as  "meteo_Ro_screen.aks"   ' name of the dispersion class statistics
os  NESTING                 ' options (here: nested grids)
z0  0.2                     ' (m) average surface roughness length
ha  11.2                    ' (m) anemometer height above ground
qs  0                       ' quality level (controls number of particles)
' sources:
hq      5                   ' (m) height of the lower edge
cq      5                   ' (m) vertical extent
xq     -8                   ' (m) lower left corner, x-coordinate
yq    -30                   ' (m) lower left corner, y-coordinate
aq     16                   ' (m) extent in x-direction
bq     60                   ' (m) extent in y-direction
' emissions:
xx    5                  ' (g/s) unspecified trace substance
odor  5000                  ' (GE/s) odorant (result: frequency of odour hours)
' monitor points:
xp  100 200 300 400 500 600 700 800   ' (m) x-coordiante
yp    0   0   0   0   0   0   0   0   ' (m) y-coordinate
---------------------------------------------------------------------------
```

Fig. 1; Example input file austal2000.txt.

Model adjustments

On a more advanced level, adjustments to country-specific demands and constraints can be implemented. For example, a land-use data base can be set up from which AUSTAL2000 then automatically determines the average surface roughness length (like it is the case in Germany). Model implementations like the boundary layer model or plume rise formulae can be adjusted or replaced by editing the source code and re-compiling the program.

STEP CALCULATION

AUSTAL2000 is executed in a command line window (DOS shell) or by a double-click in the Explorer window, no additional programs are required.

As a result, the log file austal2000.log and the text files with the 2-dimensional concentration distributions (data matrix with a Northern orientation) are written out. The latter can be inspected with a text editor or graphically visualized, e.g. using Excel.

The log file contains a list of all input parameters and their values, program version, information on the calculation process and central results of the calculation. It is essential for control purposes, e.g. by the public or involved authorities.

CONCLUSIONS

After a few adoptions, which mainly concern translations to the local language, AUSTAL2000 could be successfully run and applied in the context of Twinning Projects.

Main problems were connected to the provision of meteorological data and the quality control of the process of data acquisition, dispersion calculation, and result evaluation. Quality control was facilitated and supported by the transparency of the model structure (documentation, source code, guidelines) and the project-specific log files.

Training of inexperienced personal was strongly required and it was crucial to reserve according financial and time resources. Preparation and quality assurance should be enhanced by the provision of a detailed check list. Such a list is presently being prepared in form of the guideline VDI 3783 Part 13 (Environmental meteorology; quality control concerning impact forecast; plant-related pollution control).

REFERENCES

Janicke, L., 1983: Particle simulation of inhomogeneous turbulent diffusion. Weber, B. (Ed.), Air Pollution Modeling and its Application II, Plenum Press, New York, 527-535.

Janicke, L., 2000: A random walk model for turbulent diffusion. Reports on Environmental Physics, 1, Janicke Consulting, ISSN 1439-8222. See http://www.janicke.de.

Janicke, L., 2002: Lagrangian dispersion modelling. Particulate Matter in and from Agriculture, 235, 37-41, ISBN 3-933140-58-7.

Janicke, L. and U. Janicke, 2002: A modelling system for licensing industrial facilities. UFOPLAN 200 43 256, on behalf of the German Federal Environmental Agency (UBA). See http://www.austal2000.de.

Müller W. J., Heits B. and Schatzmann M., 2002: A prototype station for the collection of urban meteorological data, Proceedings 8th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Sofia.

TA Luft, 2002: (German Regulation on Air Quality Control) Erste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz (Technische Anleitung zur Reinhaltung der Luft - TA Luft), GMBl. 2002, 25-29, 511-605. See http://www.bmu.de/files /taluft.pdf.

VDI 3782 Part 1, 2001: Environmental meteorology; atmospheric dispersion models; Gaussian plume model for air quality management, Beuth, Berlin. See http://www.vdi.de.

VDI 3782 Part 3, 1985: Dispersion of air pollutants in the atmosphere; determination of plume rise, Beuth, Berlin. See http://www.vdi.de.

VDI 3783 Part 8, 2002 Environmental meteorology; turbulence parameters for dispersion models supported by measurement data, Beuth, Berlin. See http://www.vdi.de.

VDI 3784 Part 2, 1990: Environmental meteorology; dispersion modelling for the discharge of flue gas via cooling towers, Beuth, Berlin. See http://www.vdi.de.

VDI 3945 Part 3, 2000: Environmental meteorology; atmospheric dispersion models; particle model, Beuth, Berlin. See http://www.vdi.de.