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Results from the Sensitivity Analysis of the Model austal2000-g

The implementation of the dispersion model in the third appendix of the German Technical Instructions on Air Pollution Control (TA-Luft 2002) is making numerical simulation more important in agriculture, too. The project goal is to detect sensitive input and boundary parameters to ensure the uniform and objective application of the dispersion model austal200-g in the agricultural sector for building permit procedures. The following article focuses on the influence of the anemometer position within the orografical structured territory on the exceedence probability.

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Keywords

Numerical simulation, sensitivity analysis, austal2000-g, anemometer position

The application of numerical models during the approval process of animal husbandry facilities is gaining importance due to the amendment of the Technical Instructions on Air Quality Control (TA-Luft), especially due to the implementation of a particle model, which is described in the third appendix. From now on in the case of a legal proceeding numerical simulation can be used to obtain a forecast of the expected pollution in the vicinity of a facility.

In comparison to complex, money and time consuming on-site measurements, the application of the particle model austal2000 -g in combination with meteorological time-series readily produces results which afore could be reached only with a combination of on-site measurements, computation and meteorological knowledge.

Beside these advantages of numerical simulation one should be aware of the following risks:

- The low number of input parameters obstructs the view on the complexity of the dispersion processes
- Results are accepted uncritically
- The accuracy of the results is assumed automatically.

Till now there are no or only insufficient quality standards for numerical simulation in the agricultural field and its typical emission situations.

Comparability and transparency during the validation of previous and future results, especially on the level of the regulatory authority, are thus not ensured.

As a part of the whole evaluation process of austal2000-g, a sensitivity analysis is carried out using the conditions generally found in agricultural surroundings.

A sensitivity analysis is very useful to explain the influence of simplified assumptions and neglected parameters (over- or underestimation) [4].

The aim is to demonstrate in amount, direction and form (linear or non-linear) the influence of various input parameters on the outcomes of a numerical simulation.

The topic of the present publication is the influence of the anemometer position in hilly terrain.

Procedure

The simulations were carried out with the actual austal2000-g version 2.2.1 (compiled for Windows with the GNU-C-Compiler 3.2). Within the analysis, dust (PM100), ammonia and odour were considered.

Figure 1 shows on the left hand side an overview of the monitoring points for interpretation of the results; the positions of the anemometer are given on the right hand side of the figure.

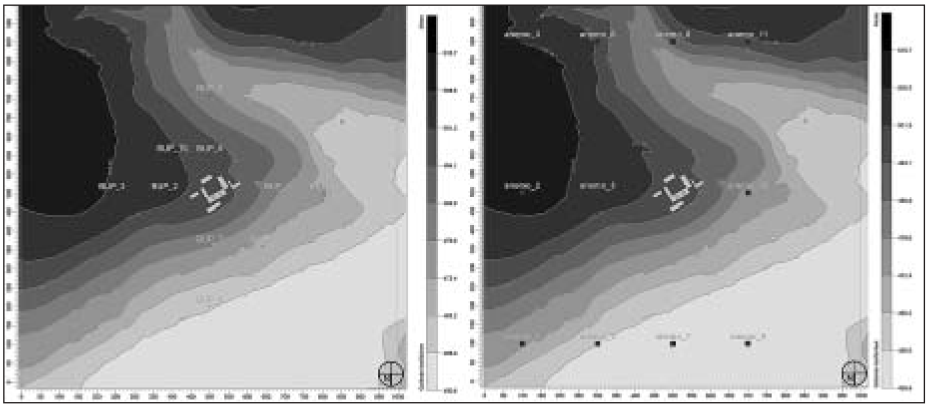

Fig. 1: Position of the monitoring points (left) and anemometer positions (right)

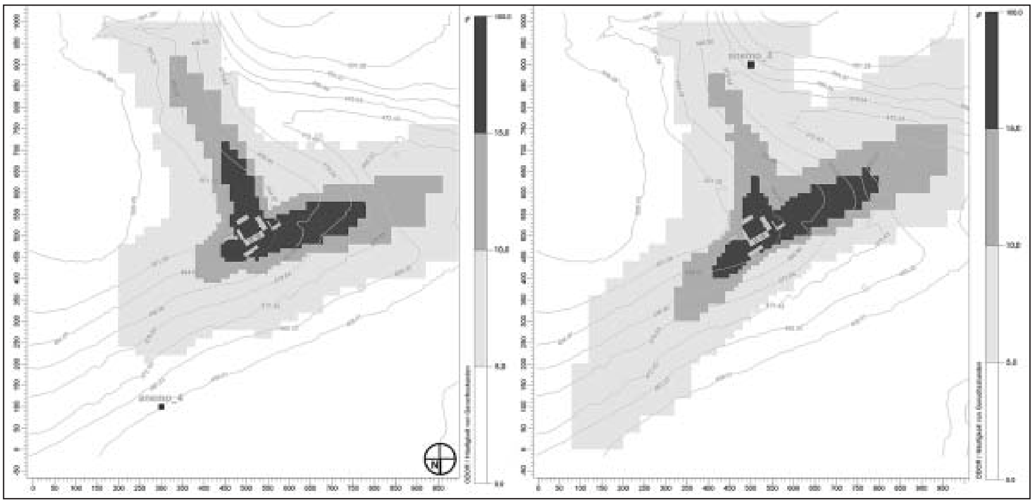

Fig. 2: Results for the anemometer position 4 and 8

This part of the sensitivity analysis was performed in hilly terrain. A maximum difference in elevation of 65 meters occurred within the considered area.

The terrain, as shown in Figure 1, too, declines from northwest to southeast. Additionally, a little valley is situated in the north.

Results

A view on the results in flat terrain shows that no differences depending on the anemometer position occur as long as the anemometer is not positioned in the wake of a building.

On the other hand, in the case of hilly terrain significant differences appear for some of the monitoring points.

An overview of the results for the ten monitoring points is given in *Table 1*.

It becomes clear that the differences depend on the allocation of the wind directions and the distance to the source.

Looking at monitoring point 1 (BUP_1) the frequency of exceedence ranges between 12.8 % to 22.8 % for the occurrence of odour. Due to closeness to the center of emission, the relevance for the approval process is obvious.

Figure 2 shows the spatial distribution of the frequency of exceedence of odour for two anemometer positions (anemo_4 und anemo_8) indicated in percent of hours per year.

A major difference between the spatial distributions can be seen for the two different anemometer positions. The differences result from the dependence of the anemometer position and the formation of the wind field in structured terrain.

The wind velocity at the position of the anemometer is used as reference value from which the wind velocities are derived for the remaining area under investigation.

A similar effect is obtained if the anemometer position is in the vicinity of a building. If the anemometer is positioned in the wake of a building, the wind velocity for the whole considered area will periodically be over-estimated.

Conclusion

The results of the sensitivity analysis show significant differences of the outcomes of numerical simulation depending on the input parameters.

It is thus indispensable that the selection of sensitive parameters for the numerical simulation is specified and constituted sufficiently.

In the case that a numerical simulation is used in a legal proceeding, it is necessary that all input parameters and their derivation are stated.

Only by this way is it possible to assure consistent and objective application of the dispersion model austal2000-g in the agricultural sector, to facilitate the reproduction of the simulation results by a third party, and to allow for an objective and independent validation of these results.

Literature

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Table1: Resuslts of the monitoring points

PUNKT	BUP_1	BUP_2	BUP_3	BUP_4	BUP_5	BUP_6	BUP_7	BUP_8	BUP_9	BUP_10	EINHEIT
xp	660	380	240	800	500	500	500	500	640	400	
yp	500	500	500	500	600	760	360	200	360	600	
hp	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
anemo-1	19.4	7.9	5.1	9.3	19.2	8.0	8.1	4.8	5.3	8.4	%
anemo-2	18.7	8.8	5.6	8.9	18.2	7.6	8.0	4.6	5.5	9.5	%
anemo-3	17.5	8.2	5.2	8.2	17.3	6.2	7.9	4.5	5.2	9.9	%
anemo-4	20.7	8.1	5.2	10.7	18.5	5.5	7.8	4.4	5.8	8.8	%
anemo-5	20.1	9.5	6.3	9.0	16.3	6.8	7.2	4.2	5.4	10.9	%
anemo-6	14.9	7.6	5.0	6.7	17.6	7.5	7.8	4.5	4.9	8.7	%
anemo-7	20.7	8.1	5.2	10.4	18.1	5.6	7.7	4.2	5.6	9.3	%
anemo-8	12.8	6.7	4.6	5.4	16.0	9.9	6.5	3.7	4.0	7.1	%
anemo-9	20.4	8.4	5.3	10.0	17.2	5.8	7.4	4.1	5.3	9.3	%
anemo-10	22.3	9.5	6.2	10.5	14.3	5.2	6.6	3.7	5.3	11.6	%
anemo-11	19.1	9.4	6.2	8.3	15.5	6.3	6.9	3.8	5.0	10.8	%