VALIDATION OF CZECH REFERENCE MODEL SYMOS'97, ADAPTED FOR ODOUR DISPERSION MODELING

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INTRODUCTION

Odorous air pollutants are considered important for their nuisance value and the number of complaints they generate. After elimination of the most serious problems caused by the polluting substances, deteriorating air quality in Czech Republic, odorants also came into focus of public and legislators. Similarly as in case of "classical" pollutants, besides the olfactometric measurements (or terrain research based on questionnaires), odour dispersion models application is also demanded, especially for the estimates of newly planned facilities impacts.

The gaussian dispersion model SYMOS97, used as a reference modeling method in Czech, has been adapted for odour dispersion modelling. Because the uncertainties connected with odour dispersion modelling are even substantial compared with models for "classical" pollutants, odour model performance is of great interest. Based on datasets published by Ingeneurbureau Lohmayer (*Bächlin W., A. Rühling and A. Lohmeyer, 2002),* validation of the adapted SYMOS97 model has been provided.

THE SYMOS´97 DISPERSION MODEL ADAPTATION FOR ODOUR MODELING

The SYMOS'97 (*Bubnik, J. and all)* dispersion model is designated for calculations of dispersion of passive (non-reactive) buoyant, continuous release from single or multiple sources which may be point, area or line sources. Five stability classes by Bubnik and Koldovsky (Czech national stability scheme based on routine observations from synoptic meteorological stations) are applied within the model. Thereof three classes describe stable stratification, the residuary ones cover neutral and convective state of the boundary layer. The modelling system enables the calculation of annual mean pollutants concentrations, maximal possible hourly concentration and annual dust fall-out. Pollutant removal from the atmosphere due to deposition or chemical transformation is involved through the decay term. Complex terrain corrections based on digital terrain model are included as a routine part of model calculations. The model is not applicable for the calm and light wind conditions.

It is well known and documented in the literature anywhere that the odour subjective perception by humans is proportional to the instantaneous peak concentration of the odorant rather then to mean values. Because the SYMOS model, similarly as other dispersion models of this class, is set for calculation of hourly mean concentrations, the basic procedure how to modify the SYMOS for odour concentration consisted in recalculation of hourly means reached in particular hours into corresponding peak values which might occur during these hours. Widely used peak-to-mean ratio (P/M ratio) approach has been selected as suitable solution of this task, as described by *Keder, J., 2003.*

The main advantage of the proposed approach inheres in the fact that most input data management and calculation procedures included in the SYMOS modelling system could be maintained. The substantial difference of the model adapted for odours is that, because owing to complicated and specific nature of odour perception it is not possible to simply sum the concentration contributions from different sources, modelling of odorant concentration field originated from only one source is recommended. The procedure is as follows: fields of maximum possible hourly concentrations are calculated from the input data on source parameters and meteorology. The corresponding stability category is recorded for each grid value. The output concentration field is subsequently recalculated into peak values using the set of peak-to-mean ratio coefficients. The coefficients value depends on the source type, stability class and on the distance of the reference point to the source (if the point falls into near- or far-field zone). The set of P/M ratios, derived by Katestone Scientific (*Freeman, T. and R. Cudmore, 2002),* has been selected and incorporated into model.

THE DATA SET USED FOR ADAPTED MODEL VALIDATION

Bächlin W., A. Rühling and A. Lohmeyer, 2002 reported on the field experiment in the surrounding of the pig farm near Stadt Biberach a. d. Riss in Germany. The site was located in the flat terrain and all experiments were performed during time with neutral stratification. An eminent collection of data resulted from this carefully prepared and perfectly organized experiment. It consists of 14 data subsets corresponding to measurements series marked from B till O. For each 10 minutes-long series a complete data on source parameters, meteorology and concentration data of odour and passive tracer are available. The concentration data were collected at the traverses in the lee of the source. Besides the concentration measurement, subjective odour intensity assessment in 6 point scale has been conducted by the panel of 12 trained persons, allocated at the testing point along the traverses. During the 10 minutes-long series the panellist recorded their estimate of odour intensity each 10 second. Thus, 60 values of the odour intensity estimates were available for each testing point and each series. Maximum estimated odour intensity value has been found for each testing point and used in subsequent analysis.

Using source and meteorology input data reported for each series, the hourly mean odour concentrations were calculated by the SYMOS model at each testing point and transformed into corresponding peak values. The paired measured and model data for series B,C and E till O were analysed and compared..

RESULTS AND CONCLUSIONS

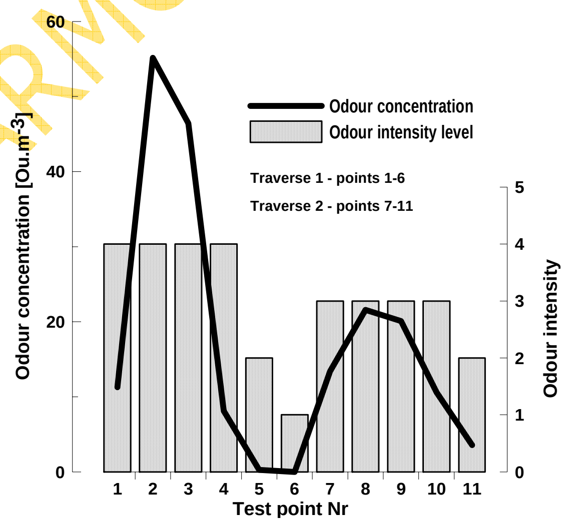

Fig. 1: Comparison of modelled odour concentrations and estimated odour intensity for series G

Comparison of odour concentration calculated by the adapted SYMOS model and odour intensity levels reported by panellists is shown at Fig. 1. Areas of high peak concentrations correspond with the higher odour intensity level assessed subjectively. According to panellist' assessment, the odour plume is wider then estimated by model.

In order to enable comparison of modelled and estimated odour intensities, function relationship among modelled peak concentrations and maximum odour intensity values reported at testing points has been found. The corresponding data pairs for all above mentioned series were grouped into 6 classes according to intensity level value. Medians of modelled odour concentrations were estimated for each class marked 0 till 5.

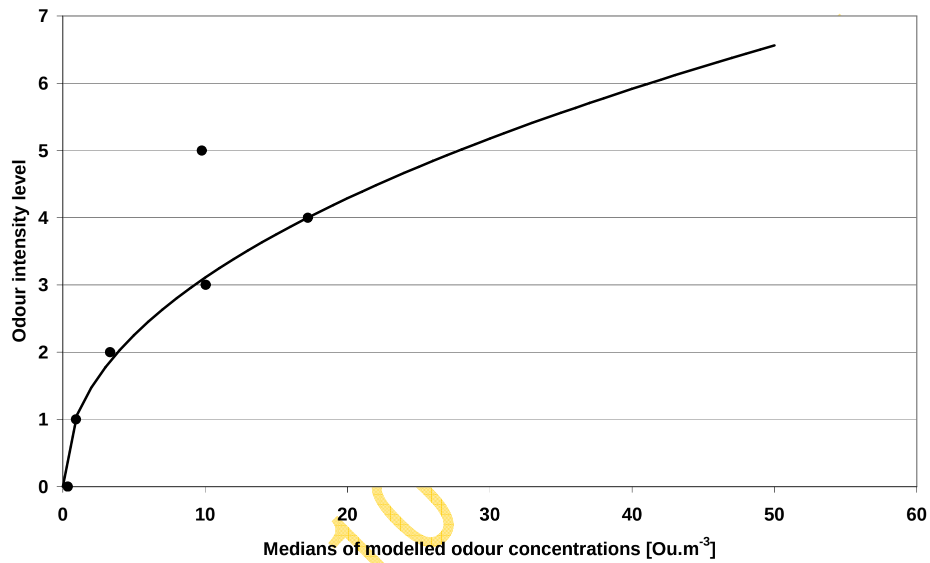

Fig. 2: Relationship among odour concentrations (class medians) and odour intensity

At Fig. 2, odour intensity levels are plotted against modelled odour concentration (class medians). The data fit curve

$$I_{od} = 1.068 C_{od}^{0.4641} \qquad (1)$$

where I_{od} reads for odour intensity and C_{od} means modelled odour concentration, follows the widely used Stevens law equation. The outlying data for intensity level 5 were omitted.

The peak odour concentrations were transformed into odour intensity levels by means of equation (1) and compared with those estimated by panellists in the field. Fig.3 shows odour concentration intensities, estimated by panellists at test points during the series G, compared with intensities derived from model calculation. A satisfactory agreement of model and experimental data are apparent from the picture. The model slightly overestimates intensity classes near the plume centreline.

Results of validation of modified model SYMOS, based on comparison with the unique experimental data, showed that despite of relative simplicity of adaptation procedure the model provides reasonable results applicable in the practice.

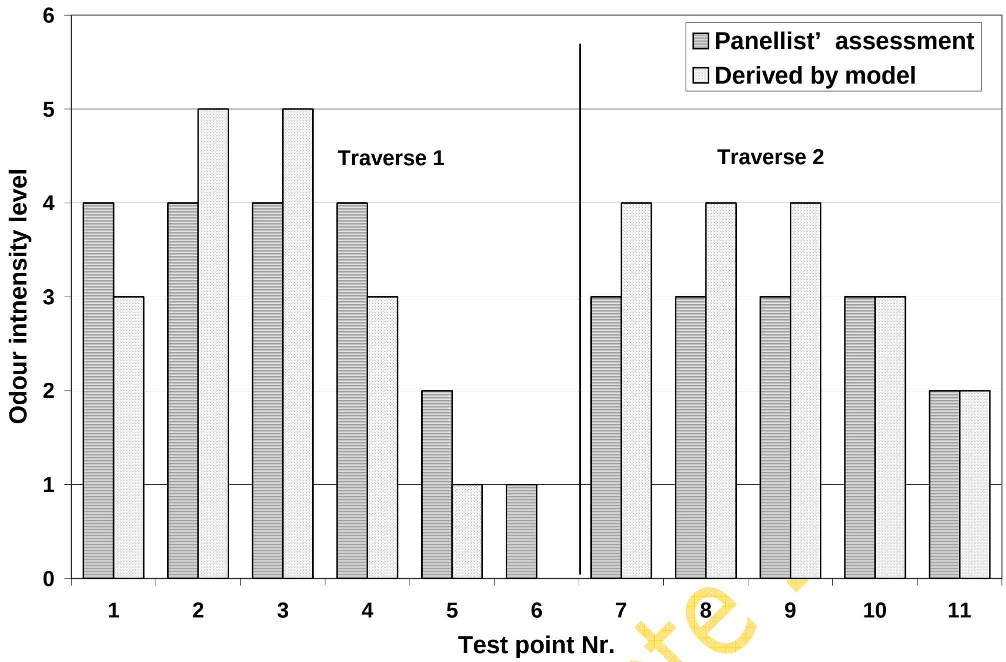

Fig. 3: Comparison of observed and modelled odour intensity level for series G

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