Tracer Experiments within an Urban Street Canyon – Field Measurements for Establishing a Validation Data Set – Experimental Realization

Contribution to subproject SATURN

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Summary

The presented project is part of the framework „Development and validation of tools for the implementation of European air quality policy in Germany" (VALIUM within AFO2000 of BMBF) co-ordinated by M. Schatzmann, University Hamburg.

The EU Air Quality Directives include air pollutant dispersion models as instruments of environmental politics. The quality of these models has to be checked. One part of that procedure is the validation, the comparison of the results of the models with specially designed and acquired reference data sets from field and wind tunnel measurements.

A data set for validation of microscale numerical dispersion models shall be compiled. Within an urban quarter around the „Göttinger Strasse" in Hanover, Germany, air pollutants and meteorological parameters are measured continuously at different sites by stations in the frame of the Lower Saxonian Monitoring System LÜN. Apart from those long term measurements three intensive measurement campaigns with additional tracer experiments are planned. During the tracer experiments, a line source of approx. 96 m length shall be operated along the median strip of the Göttinger Strasse.

In August 2001, a pretest was executed to check the experimental conception and set up. Samples of air were collected in bags at 12 locations within the street canyon and at the roofs of the buildings, and analysed later. The results show a reasonable distribution of the concentration in the street area. Later, the data will be compared to the results of wind tunnel experiments.

The first test of the experimental layout was, with minor reservations, successful. For the planned three intensive measuring campaigns, only insignificant modifications of the experimental set up will be necessary.

Introduction

The new EU Air Quality Directives include air pollutant dispersion models as instruments of environmental politics. For instance, these models allow an overall mapping of the present and future air pollutant concentration, and in a second step, the prediction of the effectiveness of proposed emission reduction measures. To avoid wrong decisions, the quality of the dispersion models needs to be controlled.

One step of that procedure is the validation of the dispersion models. For that validation, data sets from field and wind tunnel measurements are required. It must be assured, that all necessary input data are available in the data sets, and that a distinct separation between emission modelling and dispersion modelling can be made. That is possible by tracer experiments for which the released emissions can be directly measured.

Activities

Long term field measurements within a quarter of the city of Hanover will be performed to produce a validation data set for microscale dispersion models. During these measurements, additional tracer experiments will be realized.

Experimental Arrangement

The tracer experiments take place in Göttinger Strasse, Hanover. A line-shaped source is installed along the median strip of a 4 lane urban street. The source consists of 8 sections (with a tube length of 12 m each) and has a total length of approx. 96 m (Fig. 1). A mixture of the tracer gas SF_6 and air is released from small outlets in the tubes, regularly spaced every 0.4 m. The source is operated with an considerable overpressure to avoid the feedback of the natural pressure fluctuations on the release of the tracer gas. The flow rates of the SF_6 and the air are monitored continuously by flow controllers. To guarantee similar pressure and therefore release conditions along the line source, pressure gauges are mounted at each section of the source. The uniformity of the gas release within one source section was controlled in pretests for all the sections.

During the tracer experiments, the SF_6 concentration is simultaneously monitored at 12 stations within the street canyon of the Göttinger Strasse and on the flat roofs of buildings in the vicinity. During some hours, at every station the air is automatically sampled into special air sampling bags at time intervals of 30 minutes. These air samples are analysed in the laboratory later. On the roofs, also the background concentration of the SF_6 is measured.

Test measurement in August 2001

On August 8th 2001, a pretest has been performed in the Göttinger Strasse in cooperation with other researcher groups of the VALIUM project. The aim was to test the technical and logistical feasibility of the experimental concept. The line source and the technical supply were installed as planned. During the experiment, which had lasted for about 5 hours, wind direction, wind speed and pollutant concentrations were recorded on the roof and at different positions within the street canyon (Schäfer et al., 2002). Also the traffic was investigated (Kühlwein et al., 2002).

Results

During the experiment, the wind direction on the roof varied between 225 and 245 degrees which is nearly perpendicular to the orientation of the street canyon (160 - 340 degrees). The wind speed on roof level in 42 m height ranged in the same time between 6 m/s up to 12 m/s. To consider the

dependence of the concentrations on the wind direction and the wind speed the plausibility has been tested. The 30-minutes-averaged values of the concentrations seem to be reasonable.

Conclusions

The experimental conception and the arrangement passed the test successfully. Therefore, the three planned intensive measuring campaigns with tracer gas releases within the Göttinger Strasse in Hanover during the year 2002 will be performed in a similar manner with only insignificant modifications.

References

Schäfer, K., S. Emeis, H. Hoffmann; C. Jahn, W.J. Müller, B. Heits, D. Haase, and W.-D. Drunkenmölle, 2002: Validation Data for Small-scale Numerical and Physical Models of a city Quarter ,*Poster*, Symposium 2002 EUROTRAC-2, March 11-15, 2002, Garmisch-Partenkirchen, Germany.

Kühlwein, J.; and R. Friedrich, 2002: Microscale Street Canyon Emission Modelling and Vehicle Emission Factor Evaluation, *Poster*, Symposium 2002 EUROTRAC-2, March 11-15, 2002, Garmisch-Partenkirchen, Germany.

Aims of next year

Intensive measuring campaigns during different seasons will be performed.

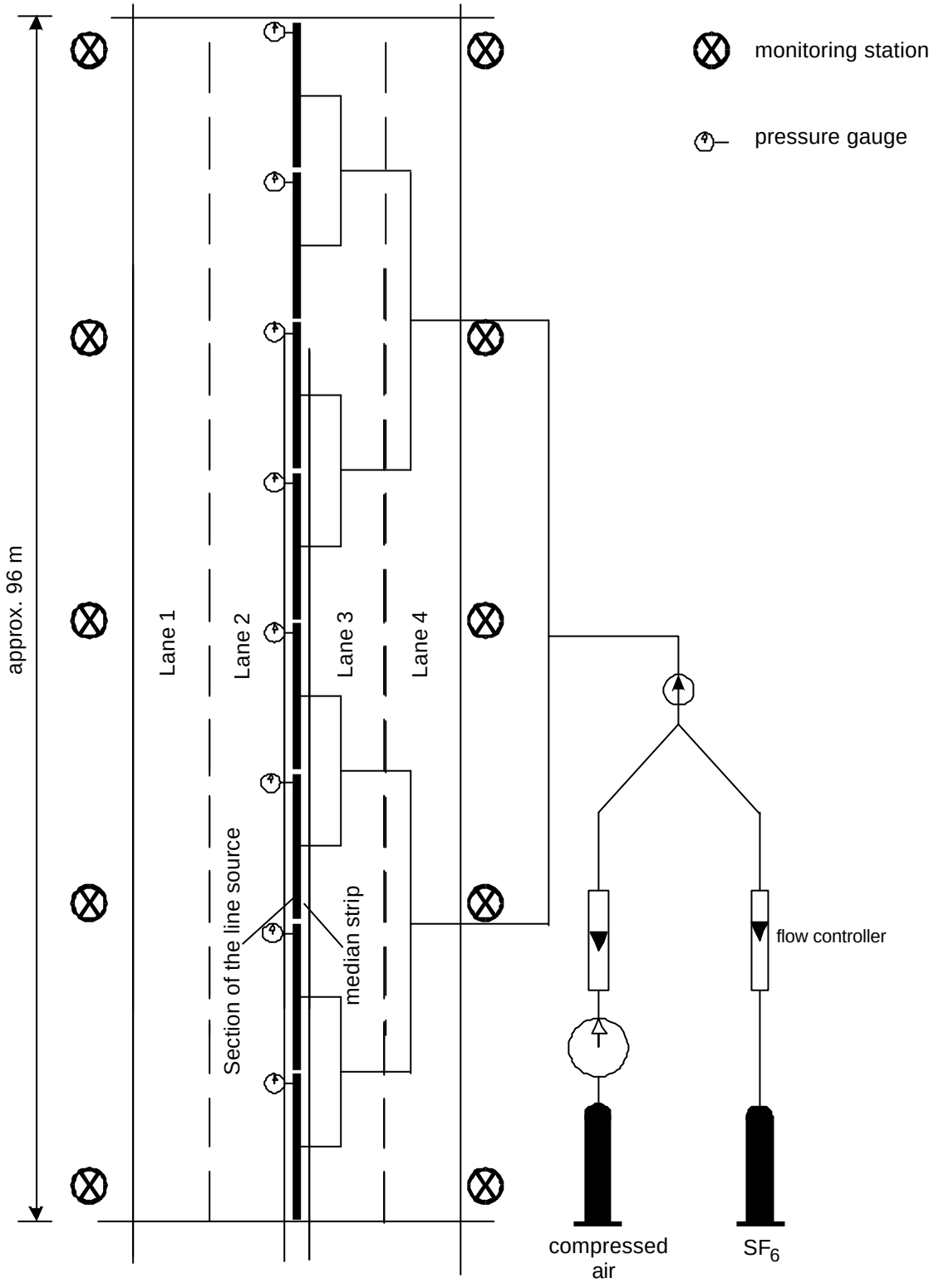

Fig. 1: Sketch of the experimental arrangement