ADMS-Roads Validation

Validation of ADMS-Roads Using the Caltrans Highway 99 Data Set

1. Introduction

The Caltrans Highway 99 experiment has been used for validating the road dispersion model Caline. The experiment was composed of two parts, the first monitored a tracer gas, SF_6, and the other part monitored CO concentrations. This document presents a comparison of ADMS-Roads modelled results with the SF_6 experiment. The road layout is shown in Figure 1, which is taken from reference [1].

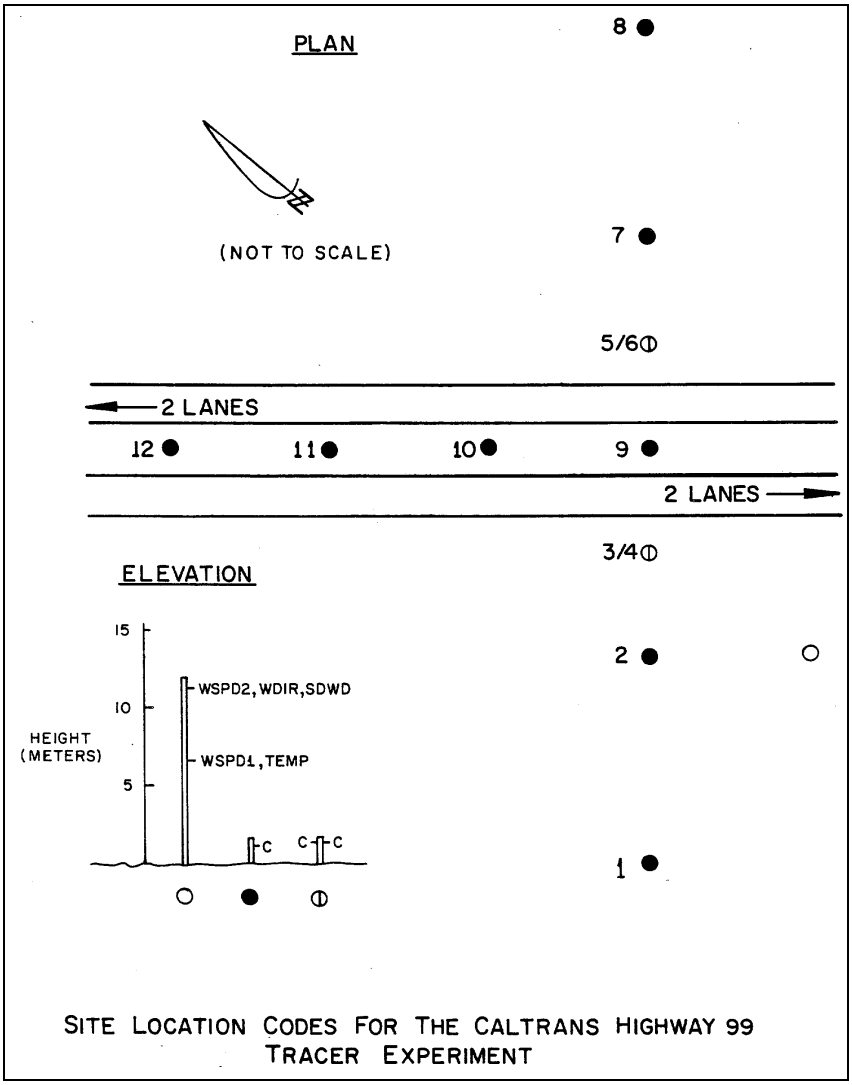

Figure 1 *Road layout from Caltrans highway 99 experiment*

The vertical monitors 2 to 7 are uniformly spaced with an interval of 50m. Monitor 1 is 100m from monitor 2, similarly for monitors 7 and 8. The four horizontal monitors are uniformly spaced along a 2.5 mile stretch of road. All monitors are at a height of 1m. The monitors measured SF_6 concentration which was emitted from eight cars driving in a circuit along the highway.

Most of the monitoring took place between 6 and 9am, in neutral or stable conditions, during winter months of 1981/82. The meteorological data was expressed in the raw data set in terms of Pasquill Stability Categories (PSC), which was converted into a value for the reciprocal of the Monin-Okukov length for input into ADMS-Roads. The values that were assumed are given in Table 1. The full set of meteorological parameters input into ADMS-Roads is given in Table 2, with the range of the data used in the study.

Table 1 *Assumed values for the reciprocal of the Monin-Obukov length*

Pasquill Stability Category	1/Lmo (m^{-1})
B	-0.1
C	-0.01
D	0
E	0.01
F	0.05
G	0.2

Table 2 *Meteorological parameters input into ADMS-Roads*

Parameter	Range of modelled data
Julian Day Number	357 to 83
Time (hours)	6 to 9am and 4 to 7pm
Wind speed (m/s)	0.1 to 5.5
Adjusted wind direction* (°)	1 to 331
Temperature (^oC)	1.1 to 13.1
Reciprocal of the Monin-Obukov length (m^{-1})	-0.1 to 0.2
Standard deviation of wind direction (°)	5.5 to 77.4

*For ease of modelling the road was assumed to run east-west, rather than southeast-northwest, and the wind direction was reduced by 45°compared to the raw data.

The road, Highway 99, is composed of two carriageways each 7.3m wide separated by a 14m wide central reservation. In the modelling a single road was input into ADMS-Roads, with a width of 28.6m. Each of the 56 sampling times which make up the experiment were modelled separately, inputting the observed traffic flow, speed and emission rate of SF_6 for each calculation.

The surface roughness used in the modelling was 0.1m, as the area surrounding Highway 99 is described as open fields and scattered residential developments. An initial mixing depth was input into ADMS-Roads, this was set to 2m for each calculation.

2. Results

Scatter plots of the calculated against monitored SF_6 concentrations are shown in Figures 2 to 11 for monitors 1 to12 respectively. The three straight lines shown on each figure are y=x, y=x/2 and y=2x, indicating when the model and observed concentrations are within a factor of two.

Statistics for the data from all samplers are given in Tables 1 and 2. The statistics have been calculated using the boot package developed by Hanna et al [2]. The following statistics are calculated:

Mean
Sigma: Standard deviation.
Bias: Mean residual = $-\overline{C}_p + \overline{C}_o$
nmse: Normalised mean square error = mean square error/$\left(\overline{C}_o \overline{C}_p\right)$
cor: Correlation.
fa2: Fraction of predictions within a factor of two of observations.
fb: Normalised bias as used by EPA. fb=$\left(\overline{C}_o - \overline{C}_p\right)/\left(0.5\left(\overline{C}_o + \overline{C}_p\right)\right)$
fs: Normalised sigma as used by EPA. fs=$\left(\sigma_o - \sigma_p\right)/\left(0.5\left(\sigma_o + \sigma_p\right)\right)$

Where $\overline{C}_o$ is the average observed concentration and $\overline{C}_p$ is the average calculated concentration.

Table 1 *SF_6 (ppt) concentration statistics (549 observations)*

Model	Mean	sigma	bias	nmse	cor	fa2	fb	fs
Observed	1059	1023	0	0	1	1	0	0
ADMS-Roads	964	1002	95.68	0.33	0.842	0.62	0.095	0.02

Table 2 *SF_6 (ppt) percentiles (549 observations)*

	99.8th percentile	99th percentile	98th percentile
Observed	4250	4044	3449
ADMS-Roads	4378	4005	3447

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References

[1] The Highway 99 Tracer experiment is described in the Caline4 (CAlifornia LINE Source Dispersion Model) manual, section 8 *Model Verification*, the raw data are given in *Appendix C* of the manual. The manual is available from Californian government web site, www.dot.ca.gov/hq/env/air/index.htm.
[2] Hanna S. R., Strimaitis D. G. and Chang J. C. (1991), "Hazard Response Modeling Uncertainty (A Quantitative Method)", Sigma Res. Corp. Report

Figure 2 *Sampler 1*

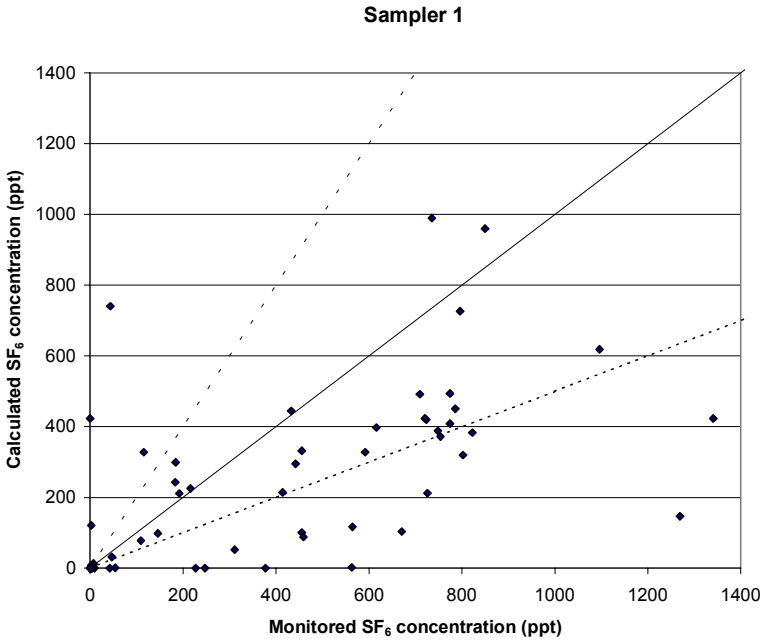

Figure 3 *Sampler 2*

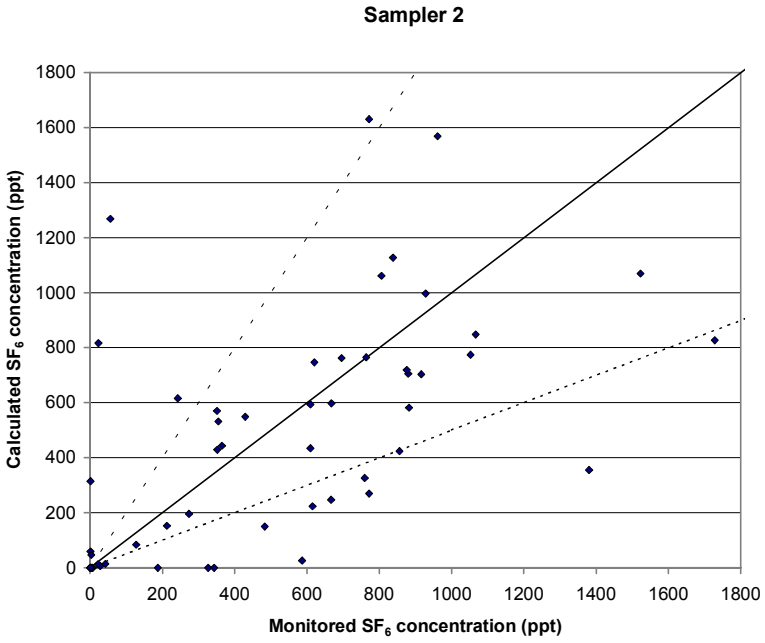

Figure 4 *Samplers 3 & 4*

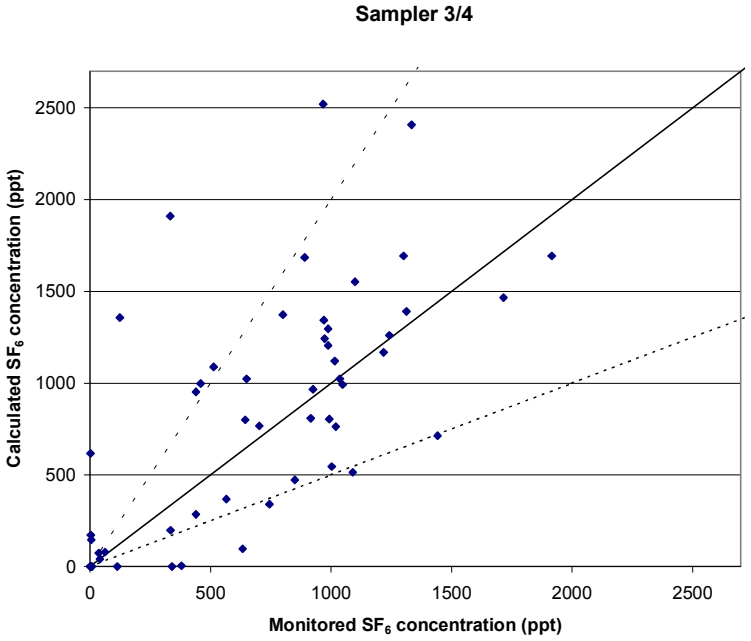

Figure 5 *Samplers 5 & 6*

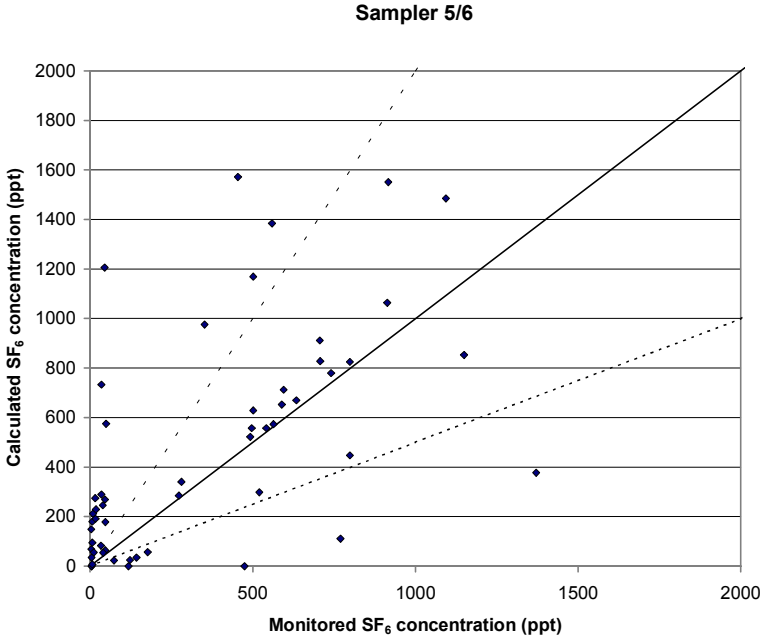

Figure 6 *Sampler 7*

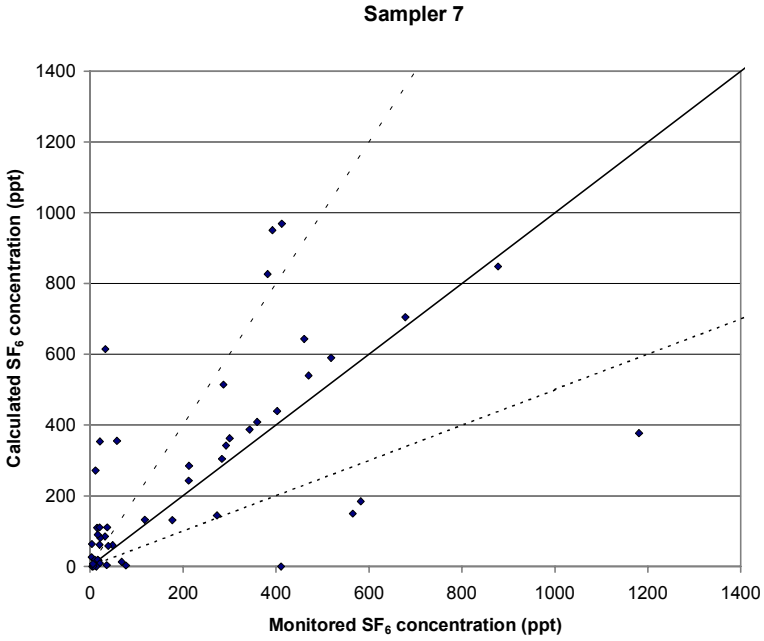

Figure 7 *Sampler 8*

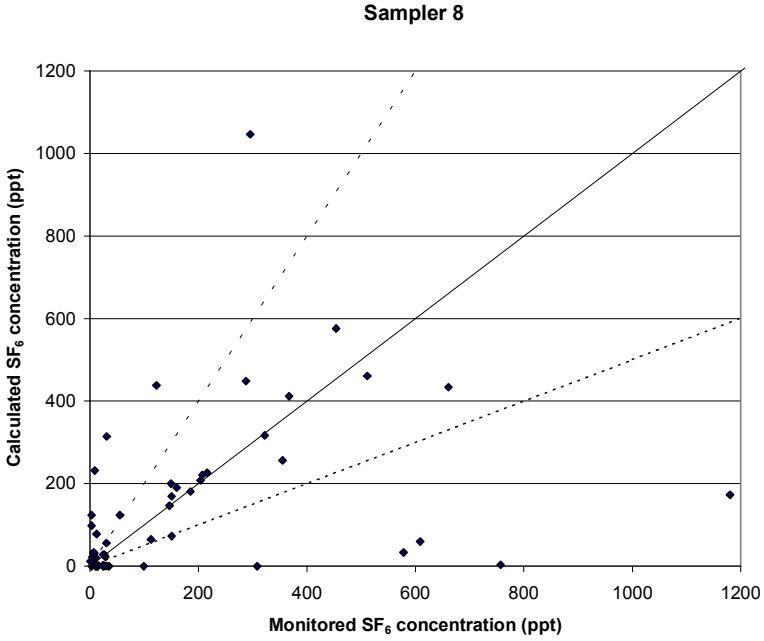

Figure 8 *Sampler 9*

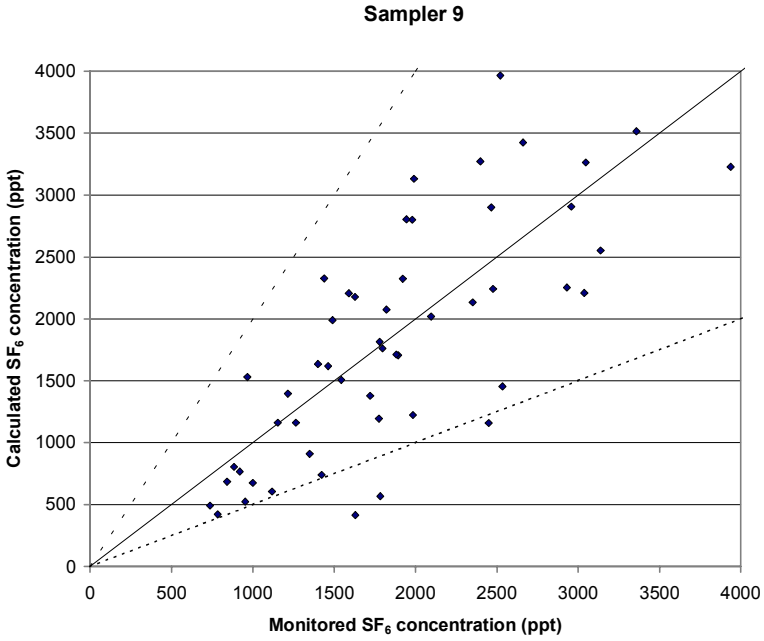

Figure 9 *Sampler 10*

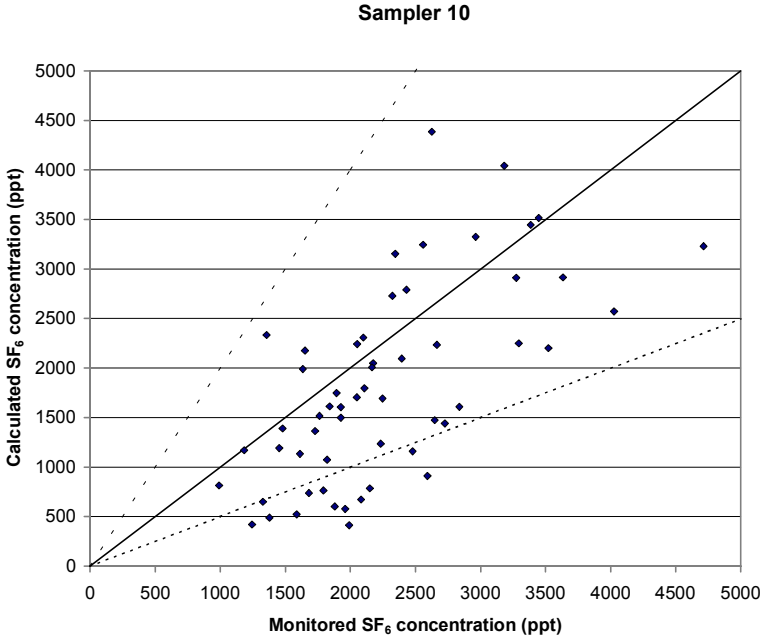

Figure 10 *Sampler 11*

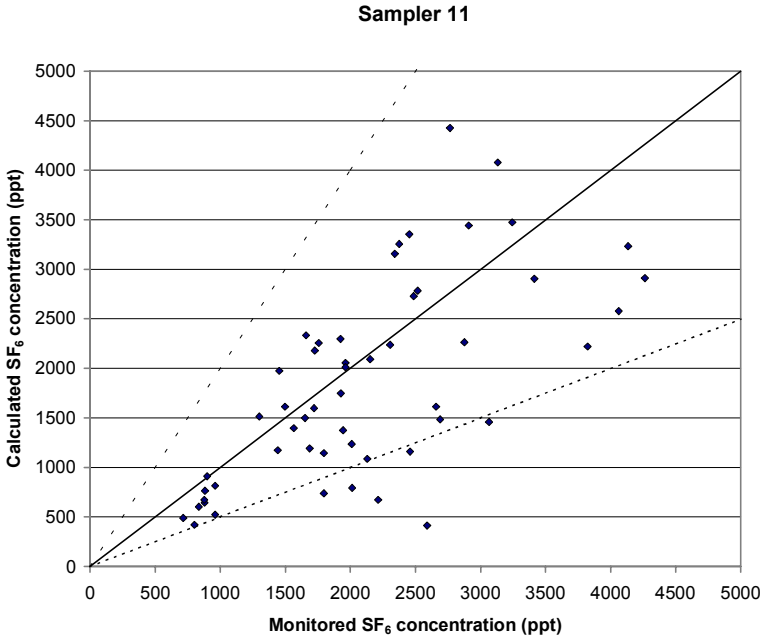

Figure 11 *Sampler 12*