ADMS 4 Buildings Validation
AGA Experiments

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1 Introduction

The American Gas Association (AGA) experiments[1] [1] occurred during spring and summer 1980 at gas compressor stations in Texas and Kansas. At each test facility, one of the gas compressor stacks was retrofitted to accommodate SF_6 tracer gas emissions. In addition, stack height extensions were provided for some of the experiments (with the normal stack height close to 10 m). The stack height to building height ratios for the tests ranged from 0.95 to 2.52.

There were a total of 63 tracer releases over the course of the tests, and the tracer samplers were located between 50 and 200 m away from the release point. **Figure 1** shows the experimental set up at the Kansas site.

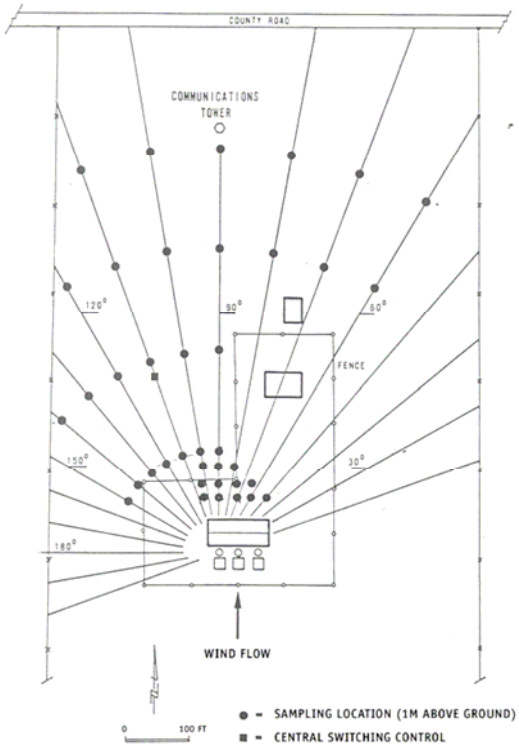

Figure 1 − AGA study area, locations of tracer samples at Kansas site.

An instrumented 10-m tower was operated at both experimental sites. The tracer releases were generally restricted to daytime hours. Meteorological conditions were mainly unstable. Wind

[1] Note that the study description and **Figure 1** have been taken directly from the document [2].

speeds ranged from 2 to 11 m/s over the 35 hours.

The input data for the ADMS runs were taken from the AERMOD files downloaded from the United States Environmental Protection Agency website [3]. These data included the arcwise maximum observed concentrations that have been used for comparison with the ADMS modelled concentrations.

This document compares the results of ADMS 4.0.2.0 (further referred to as ADMS 4.0) with those of ADMS 3.3.1.0 (further referred to as ADMS 3.3).

Section 2 describes the input data used for the model. The results are presented in Section 3 and discussed in Section 4.

2 Input data

2.1 Study area

Two sites were investigated during this study: one in Texas and one in Kansas. **Table 1** summarises the study area parameters for both sites.

Parameter	Texas site	Kansas site
Surface roughness (m)	0.1	0.1
Latitude (degrees, N)	29.0	38.2

Table 1 − Study area parameters for both sites.

2.2 Source parameters

The source parameters are summarised in **Table 2**. Each source is modelled separately for different hours. Note that the 1 g/s emission rate indicates that the observed concentrations supplied in [3] have been normalised by the emission rate.

At the Texas site, the exit velocity values were either 8.8 m/s or 15.2 m/s and the exit temperature either 362.85°C or 370.85°C, for each of the stacks for the various experiments.

Site	Source name	Pollutant	Location	Stack height (m)	Exit V (m/s)	Exit T (°C)	Diameter (m)	Emission rate (g/s)
Texas	Stack1	SF_6	(5.8, -3.3)	9.75	varied	varied	0.61	1
	Stack2	SF_6	(5.8, -3.3)	14.48	varied	varied	0.61	1
Kansas	Stack1	SF_6	(28.5, -5.0)	9.8	8.1	342.85	0.61	1
	Stack2	SF_6	(34.4, -5.0)	24.4	8.1	342.85	0.61	1

Table 2 − Source input parameters for both sites. T is the temperature, V the velocity.

2.3 Receptors

The receptor network at each of site consisted of radially spaced monitors (**Figure 2**).

For the Texas site, receptors were located at distances of 50 m, 100 m, 150 m and 200 m from the source. The measured wind directions during the experiment ranged from 60° to 180°.

For the Kansas site, receptors were located at distances of 100 m, 150 m and 200 m from the

source. The measured wind direction during the experiment ranged from 165° to 210°.

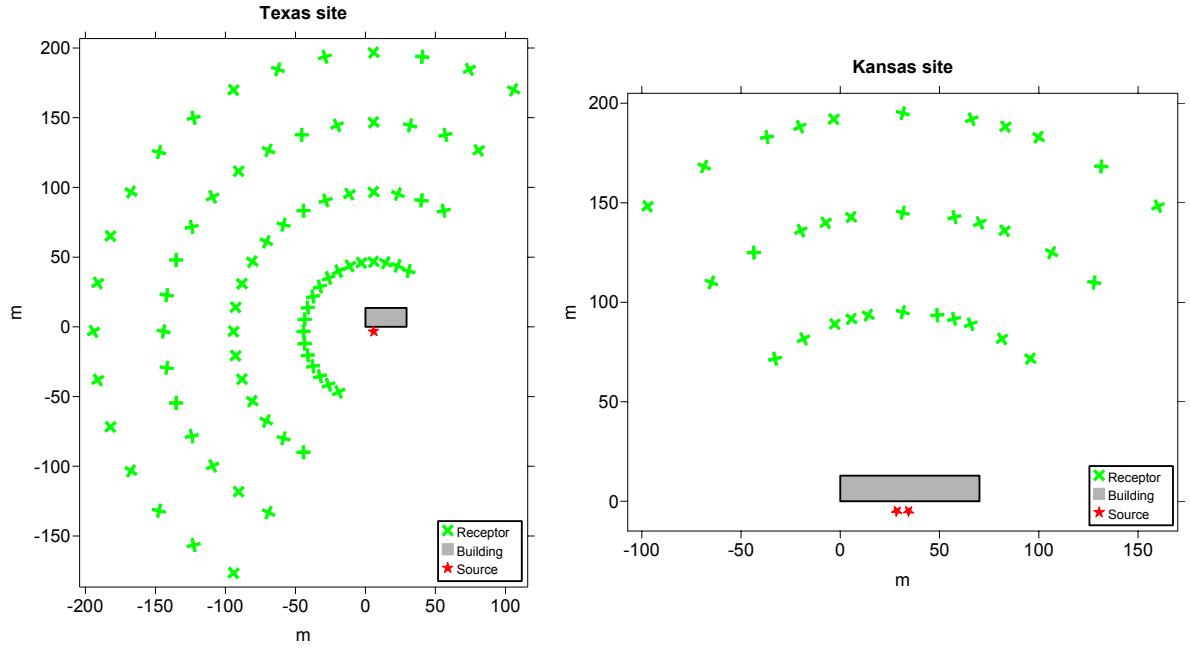

Figure 2 − The receptor network for Texas site (left) and Kansas site (right).

2.4 Meteorological data

During the Texas experiment there were 1 stable and 22 convective conditions. The wind speeds varied from 3.3 to 10.3 m/s, the ambient temperature from 12.8 to 32.8°C and the wind direction between 60 and 180°. During the Kansas experiment there were 3 stable and 9 convective conditions. The wind speeds varied from 1.3 to 6.7 m/s, the ambient temperature from 20.8 to 38.8°C and the wind direction between 165 and 210°.

Figures 3 and **4** show the wind roses for both sites. For both experiments, the height of the recorded wind was 10 m.

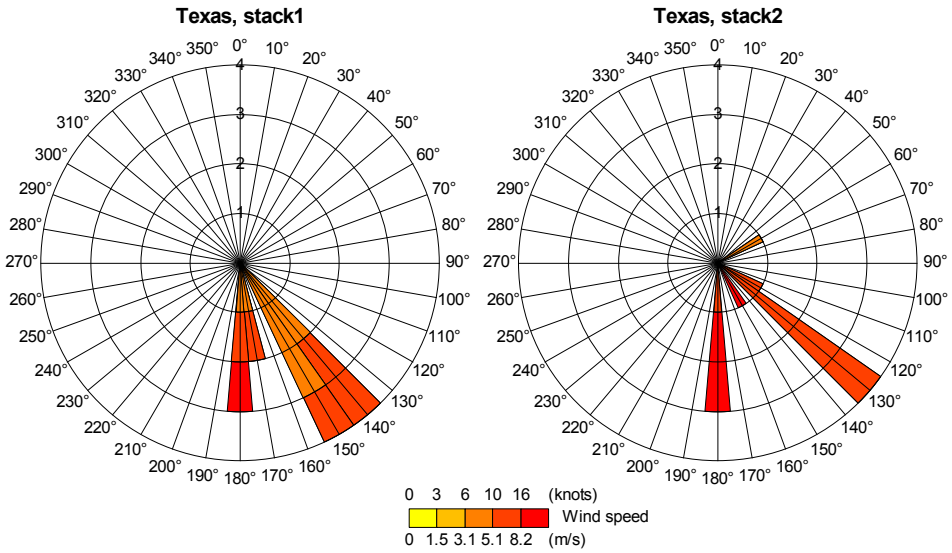

Figure 3 − Wind roses for the Texas site.

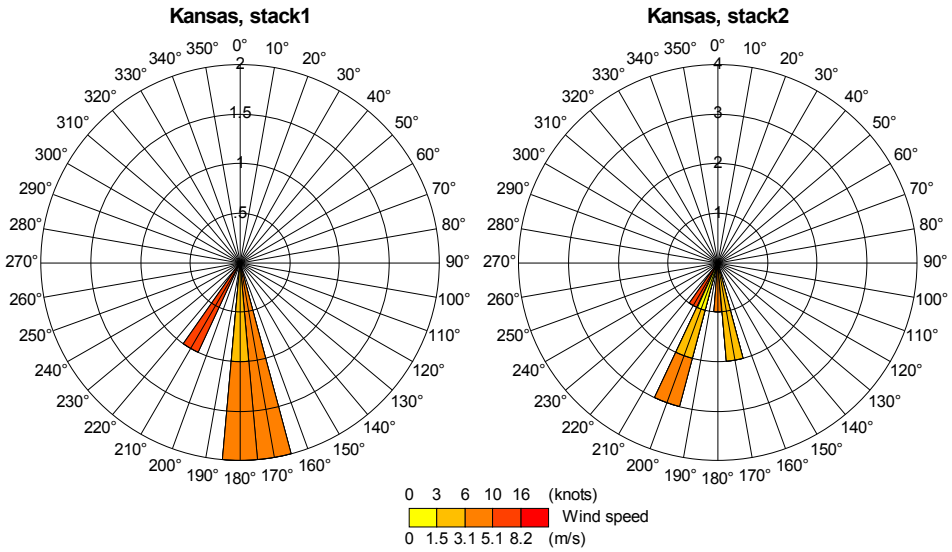

Figure 4 − Wind roses for the Kansas site.

2.5 Buildings

The building dimensions are given in **Table 3**. The building locations relative to the modelled stacks are shown in **Figure 5** (a local coordinate system has been used at each site).

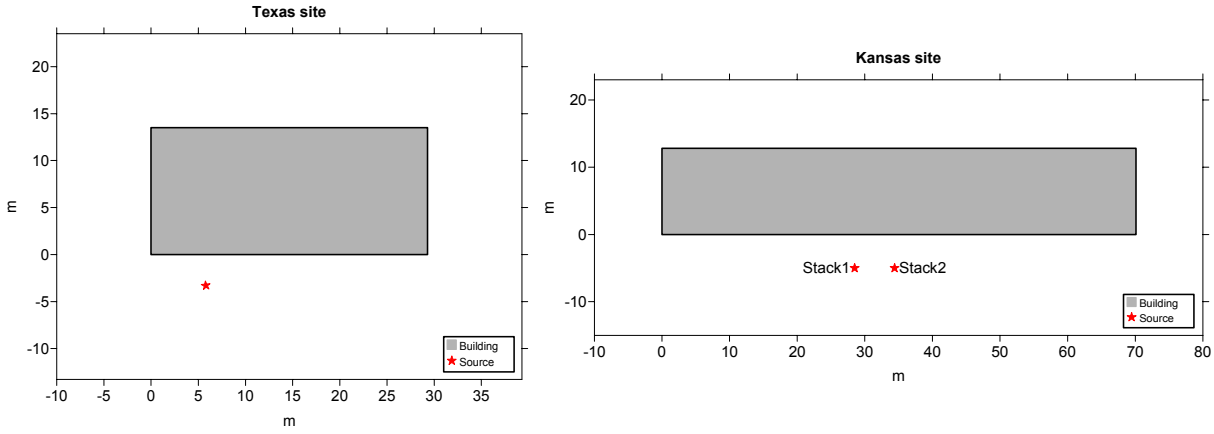

Figure 5 − The building and stack locations for the Texas site (left) and the Kansas site (right).

Site	Length (m)	Width (m)	Height (m)
Texas	29.3	13.5	11.4
Kansas	70.1	12.8	12.2

Table 3 – Dimensions of the buildings for both experimental sites.

3 Results

Scatter plots and quantile-quantile plots of model results against observed data are presented in Section 3.1. The data were also processed using the BOOT statistical package; these results are given in Section 3.2.

3.1 Scatter and quantile-quantile plots

Figure 6 shows the scatter plot of results from both sites. **Figure 7** shows the quantile-quantile plot of results from both sites. Note that these quantile-quantile plots are linear; care should be exercised when comparing these plots with similar ones presented with logarithmic axes.

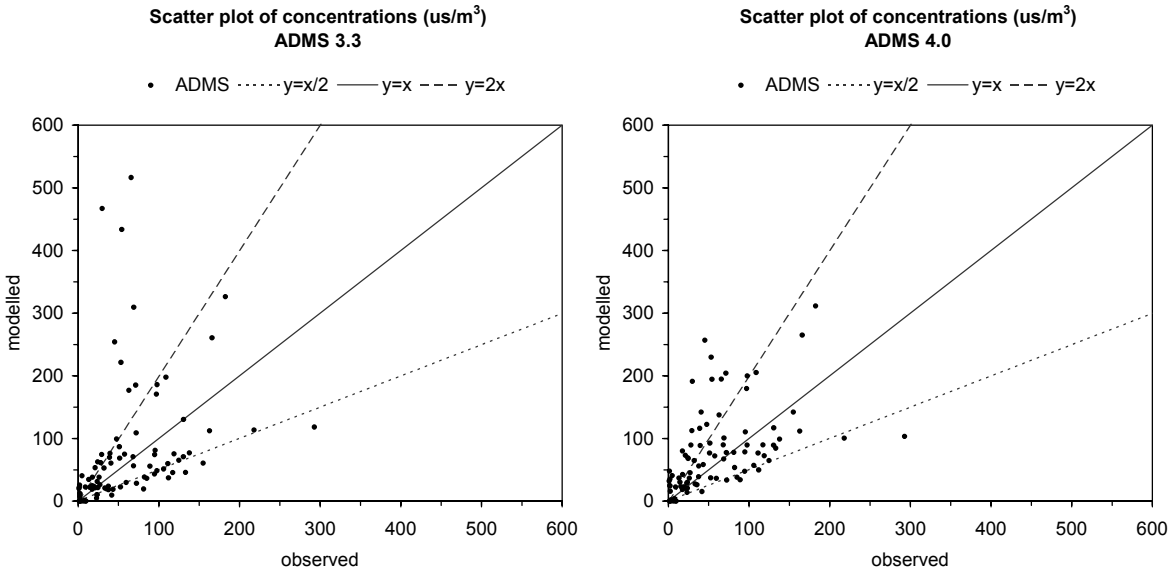

Figure 6 − Scatter plot of ADMS concentrations against observed data (us/m^3).

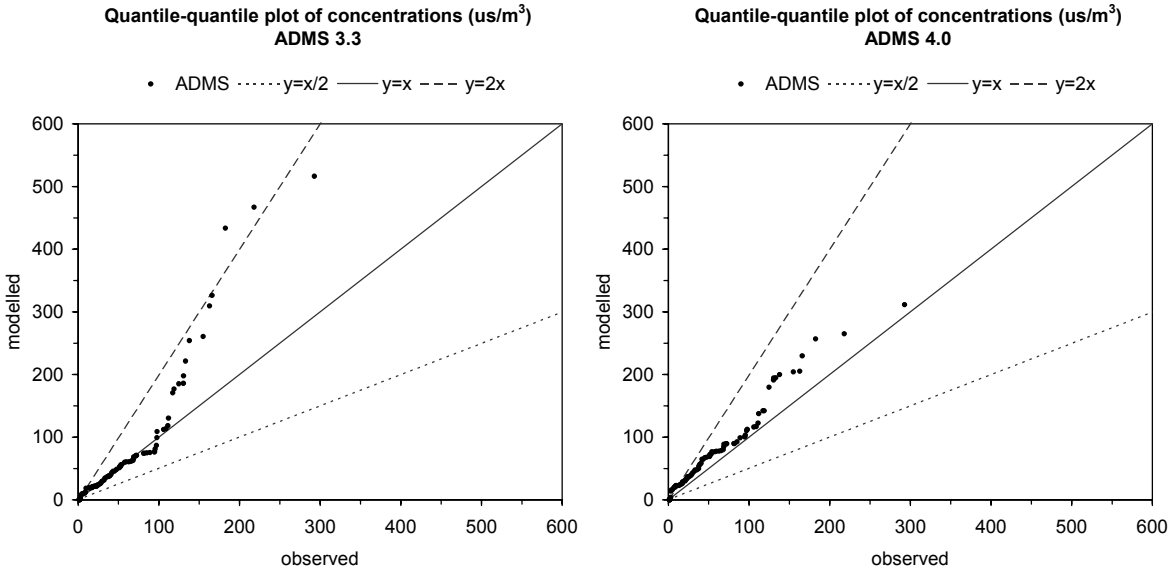

Figure 7 − Quantile-quantile plot of ADMS concentrations against observed data (us/m^3).

3.2 BOOT statistics

The BOOT package produces statistics of the data that are useful in assessing model performance. Statistics calculated include mean, standard deviation (sigma), bias, normalised mean square error (NMSE), correlation (cor), fraction of results where the modelled and observed concentrations agree to within a factor of two (fa2), fractional bias (fb) and

fractional standard deviation (fs).

Table 4 shows the results from the BOOT package for all runs from both sites. **Tables 5** to **8** show the results from the BOOT package for the Texas and Kansas sites separately, for different stacks modelled.

Data	Mean	Sigma	Bias	NMSE	Cor	Fa2	Fb	Fs
observed	58.66	54.09	0.00	0.00	1.000	1.000	0.000	0.000
ADMS 3.3	76.27	99.93	-17.61	2.15	0.333	0.429	-0.261	-0.595
ADMS 4.0	75.86	65.81	-17.20	0.89	0.507	0.505	-0.256	-0.196

Table 4 − BOOT statistics for both sites.

Data	Mean	Sigma	Bias	NMSE	Cor	Fa2	Fb	Fs
observed	64.83	37.35	0.00	0.00	1.000	1.000	0.000	0.000
ADMS 3.3	48.85	25.43	15.99	0.44	0.468	0.680	0.281	0.380
ADMS 4.0	68.21	31.80	-3.38	0.30	0.465	0.800	-0.051	0.161

Table 5 − BOOT statistics for Texas site (14.48 m stack).

Data	Mean	Sigma	Bias	NMSE	Cor	Fa2	Fb	Fs
observed	93.99	58.39	0.00	0.00	1.000	1.000	0.000	0.000
ADMS 3.3	147.34	128.79	-53.36	1.72	-0.061	0.400	-0.442	-0.752
ADMS 4.0	126.17	72.36	-32.18	0.75	0.096	0.457	-0.292	-0.214

Table 6 − BOOT statistics for Texas site (9.75 m stack).

Data	Mean	Sigma	Bias	NMSE	Cor	Fa2	Fb	Fs
observed	16.10	13.36	0.00	0.00	1.000	1.000	0.000	0.000
ADMS 3.3	29.60	23.53	-13.50	0.82	0.830	0.385	-0.591	-0.551
ADMS 4.0	31.20	25.55	-15.10	1.10	0.745	0.462	-0.638	-0.626

Table 7 − BOOT statistics for Kansas site (9.8 m stack).

Data	Mean	Sigma	Bias	NMSE	Cor	Fa2	Fb	Fs
observed	12.13	11.80	0.00	0.00	1.000	1.000	0.000	0.000
ADMS 3.3	9.84	8.86	2.29	1.41	0.264	0.167	0.209	0.284
ADMS 4.0	20.90	19.36	-8.77	1.84	0.274	0.222	-0.531	-0.485

Table 8 − BOOT statistics for Kansas site (24.4 m stack).

4 Discussion

The scatter and quantile-quantile plots shown in Section 3.1, and the BOOT statistics averaged over all sites in Section 3.2 (**Table 4**) show reasonably good agreement for both ADMS 3.3 and ADMS 4.0 with monitored concentatrions.

Comparing the two versions of the model, ADMS 4.0 is seen to perform better than ADMS 3.3, for example:

- In the scatter plot (**Figure 6**) there are no significant over-predictions of observed

values for ADMS 4.0 (a few of these were seen in ADMS 3.3).

- The quantile-quantile plot for ADMS 4.0 lies close to the 'modelled = observed' line, whereas for ADMS 3.3, although this is also the case for lower concentrations, some of the higher observed values are over-predicted.
- ADMS 4.0 performs better than ADMS 3.3 on every statistic presented in **Table 4**, when results are averaged over both sites.

When the results are analysed on a site-by-site and stack-by-stack basis using BOOT (as presented in **Tables 5** to **8**), it can be seen that whilst ADMS 4.0 performs significantly better than ADMS 3.3 at the Texas site, at the Kansas site, ADMS 3.3 performs better that ADMS 4.0 for all statistics, apart from the fraction of modelled values within a factor of two of the observed data and the correlation at the 24.4 m stack. The overall statistics presented in **Table 4** demonstrate that ADMS 4.0 out-performs ADMS 3.3.

5 References

[1] Engineering Science, 1980: *Field Validation of Atmospheric Dispersion Models for Natural Gas Compression Stations*. Report No. PR-133, prepared for the American Gas Association. (not used?)

[2] United States Environmental Protection Agency, 2003: *AERMOD, Latest Features and Evaluation Results*. EPA-454/R-03-003.

[3] United States Environmental Protection Agency website, *Model Evaluation Databases*. http://www.epa.gov/scram001/dispersion_prefrec.htm