ADMS 4 Buildings Validation
Bowline Point Site

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1 Introduction

The Bowline Point[1] site is located in the Hudson River valley in New York State (as shown in **Figure 1**). There are two stacks of height 86.9 m, close to the western shore of the river. The emissions from the stacks were buoyant and varied hour by hour, and very close to the stacks there was a complex of buildings. The site itself was rural and the terrain was relatively flat, although there was an urban area to the west of the site, and some significant hills to the south-west.

There were four monitoring sites; their distances from the stacks ranged from 250 to 850 m. Two of the monitors were to the south-east of the site; the others were to the north and west.

Hourly meteorological data were obtained from a 100-m mast on the site for the whole year 1981. The prevailing wind was from the north-west.

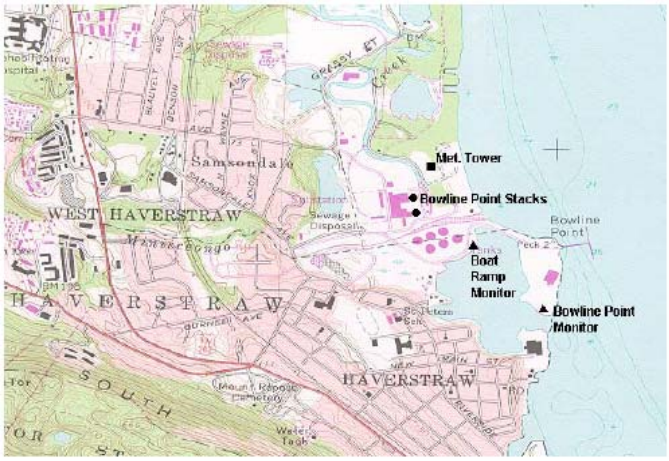

Figure 1 – Bowline Point study area.

The input data for the ADMS runs were taken from the AERMOD files downloaded from the United States Environmental Protection Agency website [2]. These data included the 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.

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

2 Input data

This study involves the modelling of a two stacks in close proximity to a number of buildings. Study details are given in Sections 2.1 to 2.5 below.

2.1 Study area

The latitude of the site is 41.2°N and the surface roughness was taken to be 0.03 m.

2.2 Source parameters

The source parameters are summarised in **Table 1**. For the first stack (second stack), the exit velocity varied between 7.9 and 27.9 m/s (8.6 and 30.9 m/s), the exit temperature between 84.9 and 126.9°C (89.0 and 136.1°C) and the emission rate between 0 and 449.3 g/s (0 and 431.3 g/s).

Source name	Pollutant	Location	Stack height (m)	Exit V (m/s)	Exit T (°C)	Diameter (m)	Emission rate (g/s)
Stack1	SO_2	(7.78, -44.13)	86.87	varied	varied	5.72	varied
Stack2	SO_2	(-7.78, 44.13)	86.87	varied	varied	5.72	varied

Table 1 − Source input parameters. T is the temperature, V the velocity.

2.3 Receptors

There were four monitoring sites located around the stacks as shown in **Figure 2**.

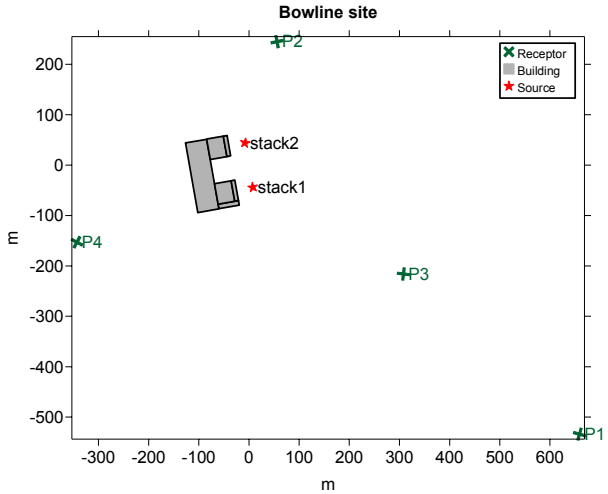

Figure 2 – Locations of buildings and stacks.

2.4 Meteorological data

The experiment used 1 year of hourly sequential data from the 1 January 1981 to 31 December 1981. Hourly meteorological data were obtained from a 100-m mast on the site. **Table 2** gives the detail of the modelled meteorological conditions.

Conditions		ADMS 3.3	ADMS 4.0
Hours modelled	Stable conditions	3982 (57%)	3982 (57%)
	Neutral conditions	544 (8%)	544 (8%)
	Unstable conditions	2476 (35%)	2476 (35%)
	Total	*7002 (100%)*	*7002 (100%)*
Hours not modelled	Calm conditions	466	0
	Wind speed at 10 m < 0.75 m/s	1292	1292
	Inadequate data	0	466
	Total	*1758*	*1758*

Table 2 – Meteorological conditions.

The wind speed varied between 0.4 and 19 m/s and the wind direction between 0 and 360° (the prevailing wind was from the north-west). The ambient temperature varied between -19.2 and 33.9°C. The height of the recorded wind used was 100 m. The wind rose is shown in **Figure 3**.

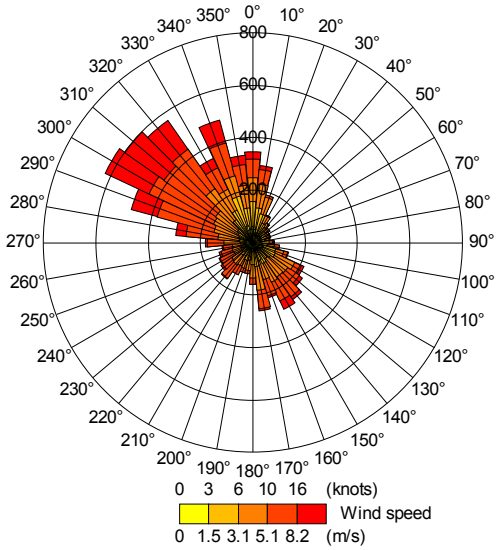

Figure 3 – Wind rose.

2.5 Buildings

The building dimensions are given in **Table 3**. **Figure 4** shows the locations of the buildings.

Building name	Length (m)	Width (m)	Height (m)
WHOUSE1A	140.21	42.82	29.57
WHOUSE1B	9.15	41.2	29.57
WHOUSE2	41.2	33.53	65.23
WHOUSE3	41.2	7.62	38.4
WHOUSE4	41.2	33.53	65.23
WHOUSE5	41.2	7.62	38.4

Table 3 – Dimensions of the buildings.

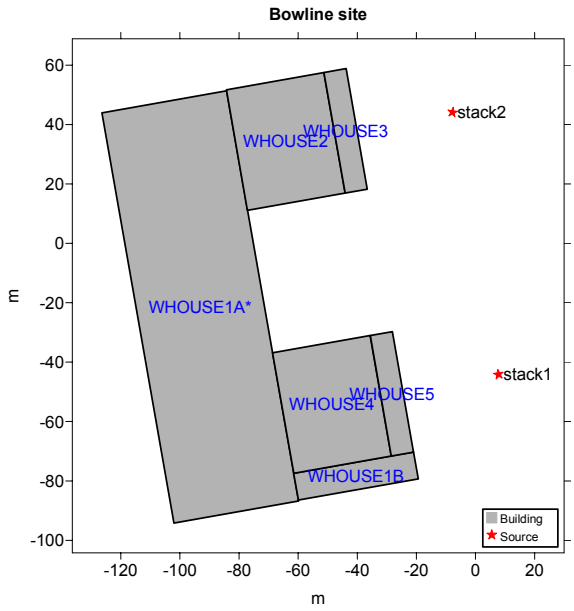

Figure 4 – Stack and building locations.

3 Results

Scatter plots and quantile-quantile plots of model results against observed data are presented in Section 3.1. Other statistical analysis of the data is presented in Section 3.2.

3.1 Scatter and quantile-quantile plots

Figure 5 shows the scatter plots and the quantile-quantile plots of modelled versus observed hourly average concentrations.

Note that these quantile-quantile plots are linear; care should be exercised when comparing these plots with similar ones presented with logarithmic axes.

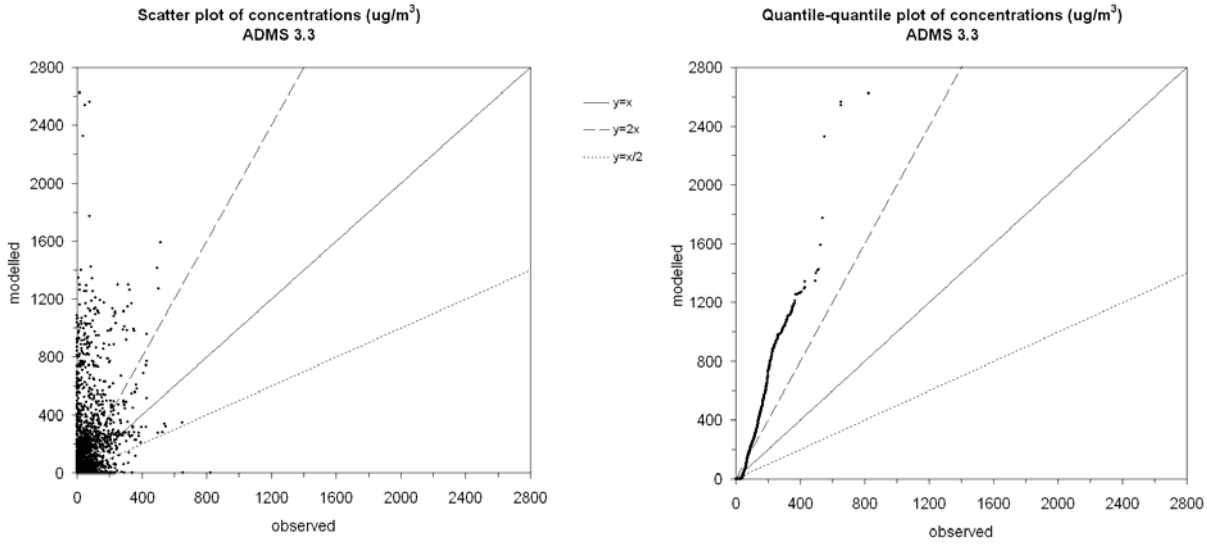

Figure 5 – Scatter plots and quantile-quantile plots of modelled against observed hourly average concentrations (ug/m^3).

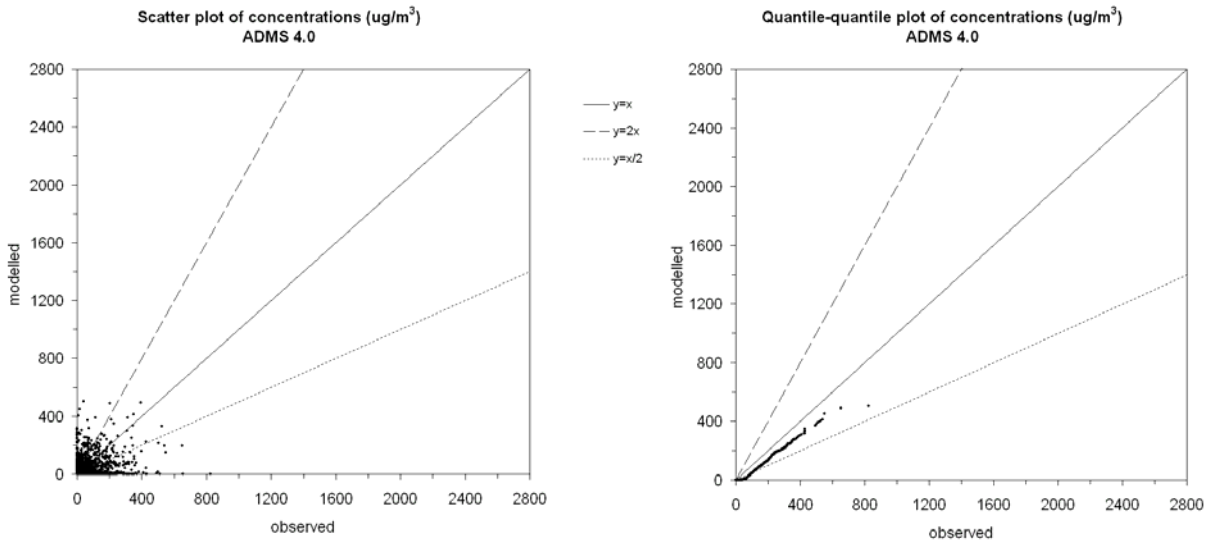

Figure 5 − continued.

3.2 Statistics

Table 4 compares the modelled and observed maximum 1-hour, 3-hour and 24-hour average concentrations and annual mean concentrations. Some average statistics are also given.

Table 5 presents modelled to observed ratio of the robust highest concentrations.

Statistics	Data	Concentrations (ug/m^3)				Mean M/O ratio	
		P1	P2	P3	P4	all P	P1 & P3
1-hour maximum	observed	824	343	514	85	-	-
	ADMS 3.3	1340	323	2622	207	2.53	3.36
	ADMS 4.0	329	65	503	243	1.11	0.69
3-hour maximum	observed	589	153	388	71	-	-
	ADMS 3.3	716	108	1728	196	2.28	2.83
	ADMS 4.0	280	24	396	228	1.22	0.75
24-hour maximum	observed	229	55	193	64	-	-
	ADMS 3.3	333	20	509	40	1.27	2.05
	ADMS 4.0	86	5	119	48	0.46	0.50
annual mean	observed	21.3	5.2	19.1	8.9	-	-
	ADMS 3.3	29.6	1.4	48.6	1.3	1.09	1.97
	observed	20.2	4.5	18.3	8.0	-	-
	ADMS 4.0	9.6	0.1	4.3	1.5	0.23	0.35

Table 4 − Observed (O) and modelled (M) concentrations.

Data	1-hour	3-hour	24-hour
ADMS 3.3	3.18	3.03	2.93
ADMS 4.0	0.75	0.74	0.53

Table 5 – Ratio of modelled/observed robust highest concentrations (number of points = 26).

4 Discussion

4.1 Validation method

It should be noted that prediction of hour-by-hour concentrations at a point is very difficult being very sensitive to the precise wind direction during the hour. In addition the measured concentration is subject to stochastic variation whereas the models are predicting the ensemble mean.

The scatter plots compare predicted and measured concentrations at a particular location at a particular time, i.e. an (x,t) pairing. The quantile-quantile plots compare the distribution of predicted and measured concentrations during the period having abandoned the (x,t) pairing. Predicting the distribution of concentrations accurately is relevant to calculations for permitting purposes, where the comparison with air quality limits is more important than accurately predicting a time series of concentrations at each location. The latter is a harder task.

Averaged results such as the 24-hour and annual average concentrations should be better predicted by the model than 1- and 3-hourly average concentrations.

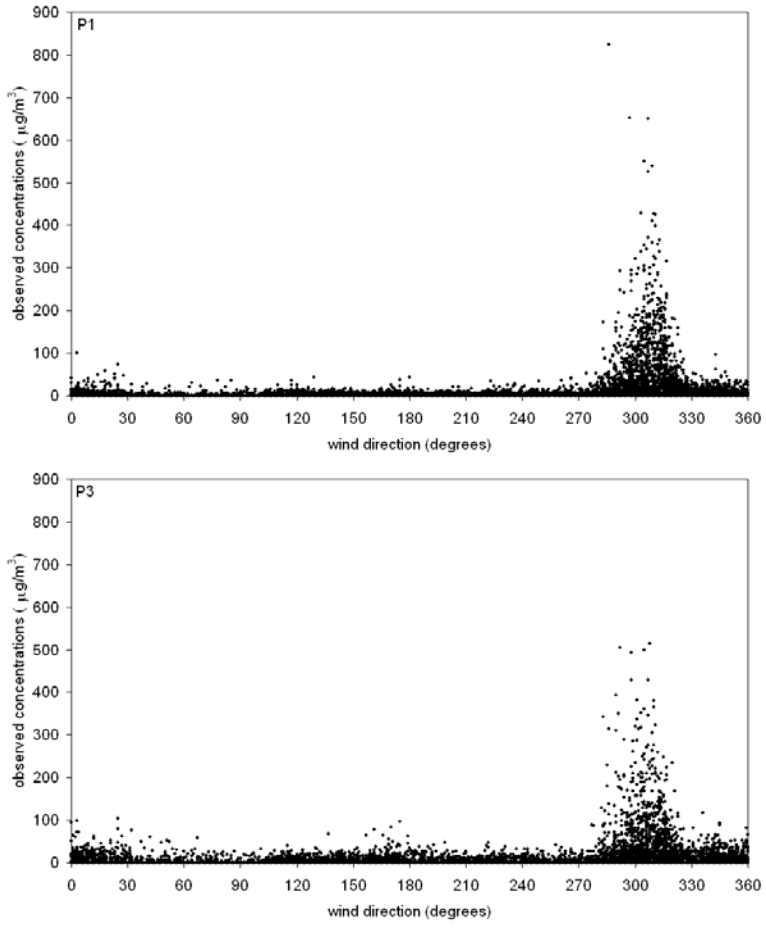

Figure 6 – Observed concentrations at receptors P1 and P3 (both south-east of the stacks), plotted against the wind direction. Note that the concentration is non-zero for all wind directions.

For this particular study, the background concentration is an issue. **Figure 6** shows the

concentration at two monitoring sites (P1 and P3) as a function of wind direction. This figure indicates that there is some concentration at the monitors *even when the wind is not blowing from the power plant*. This affects in particular the long term averages and having neglected background concentrations, we would expect the models to underestimate long term means.

4.2 Buildings

In the ADMS 4.0 modelling, all buildings were included. The heights of buildings 1A, 1B, 2 and 3 are all approximately half of the stack height or less, and these buildings are therefore unlikely to have a large effect on the dispersion of such buoyant releases as those from Stack1 and Stack2. As the prevailing wind is from the north-west, building 2 has a more significant impact than building 4.

4.3 Conclusions

As the prevailing wind was from the north-west, there are few useful concentration measurements at receptors P2 and P4, so the results at receptors P1 and P3 are the most robust.

The scatter and quantile-quantile plots (**Figure 5**) show that ADMS 4.0 performs significantly better than ADMS 3.3. In particular, the large number of observed values that were over-predicted by ADMS 3.3 are much better modelled by ADMS 4.0; the ADMS 4.0 quantile-quantile plot is particularly good.

ADMS 4.0 gives good predictions of the observed maximum concentrations (refer to **Tables 4** and **5**), whilst ADMS 3.3 generally over-predicts values.

5 References

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

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