

ADMS 4 Complex Terrain Validation *Westvaco Corporation*

Cambridge Environmental Research Consultants
June 2007

1 Introduction

The Westvaco Corporation's pulp and paper mill¹ in rural Luke, Maryland is located in a complex terrain setting in the Potomac River valley [2]. A single 190-m buoyant source was modelled for this evaluation. There were 11 SO₂ monitors surrounding the facility, with eight monitors well above stack top on the high terrain east and south of the mill at a distance of 800-1500 m (**Figure 1**).

Hourly meteorological data (wind, temperature, and turbulence) were collected between December 1980 and November 1981 at three instrumented towers: the 100-m Beryl tower in the river valley about 400 m southwest of the facility, the 30-m Luke Hill tower on a ridge 900 m north-northwest of the facility, and the 100-m Met tower located 900 m east-south-east of the facility on a ridge across the river.

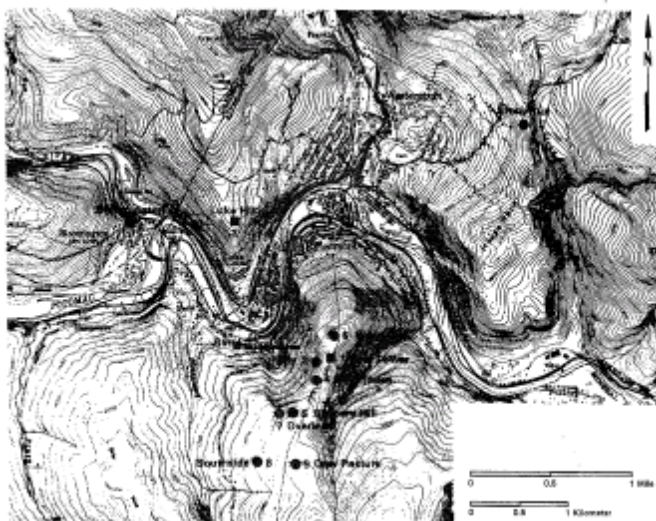


Figure 1 – Locations of SO₂ monitors and meteorological towers in the vicinity of the Westvaco Luke Mill.

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 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).

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

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

The site was located at 39.47°N. The surface roughness used varied between 0.6 and 1.3 m depending on the time of the year.

Terrain data included in the modelling covered a 6 km x 7 km area (as shown in **Figure 2**). Terrain data points were located every 160 m within this area.

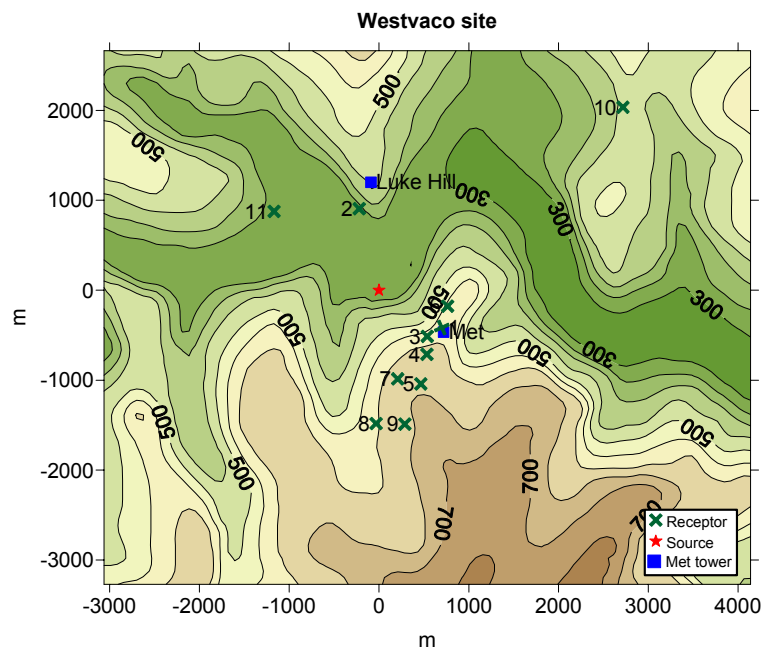


Figure 2 – Modelled terrain area around the Westvaco Corporation.

2.2 Source parameters

The source parameters are summarised in **Table 1**. Each of these sources is modelled separately for different hours. The exit velocity varied from 7.2 to 35.7 m/s, the exit temperature from 92.9 to 129.9°C and the emission rate varied from 42.8 g/s to 635 g/s.

Source name	Pollutant	Location	Stack height (m)	Exit V (m/s)	Exit T (°C)	Diameter (m)	Emission rate (g/s)
Stack	SO ₂	(0,0)	189.7	varied	varied	3.36	varied

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

2.3 Receptors

The receptor network at each of site consisted of 11 monitors located as shown in **Figure 2**.

2.4 Meteorological data

The experiment used 1 year of hourly sequential data from the 1 December 1980 to 30 November 1981.

Table 2 gives the detail of the modelled meteorological conditions.

Conditions		ADMS 3.3	ADMS 4.0
Hours modelled	Stable conditions	4447 (56%)	4283(61%)
	Neutral conditions	1137 (14%)	428 (6%)
	Unstable conditions	2410 (30%)	2329 (33%)
	<i>Total</i>	<i>7994 (100%)</i>	<i>7040 (100%)</i>
Hours not modelled	Calm conditions	0	0
	Wind speed at 10 m < 0.75 m/s	632	1586
	Inadequate data	134	134
	<i>Total</i>	<i>766</i>	<i>1720</i>

Table 2 – Meteorological conditions. Percentage values are computed with respect to the total number of modelled hours.

The wind speeds varied from 0.3 to 14.7 m/s and the wind direction was either westerly or easterly for the majority of the study duration (see the wind rose shown in **Figure 3**). The height of the recorded wind is 30 m. The ambient temperature varied from -19.7 to 29.5°C.

ADMS 4.0 has used a profile of wind speeds and temperature with readings at 30, 50 and 100 m; it was based on recorded wind speeds at the Luke Hill (30 m) and ‘Met’ (50 and 100 m) instrumented towers (see location on **Figure 2**). A correction factor is applied to wind speed data at the met. sites to account for the difference in location; this factor ranges from 60% at 10 m to 33% at 100 m.

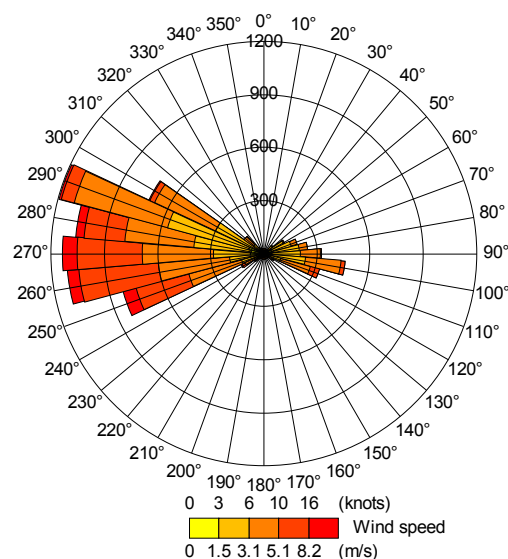


Figure 3 – Wind rose.

3 Results

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

3.1 Scatter and quantile-quantile plots

Figure 4 shows the scatter plots and quantile-quantile plots of results for hourly mean concentrations. Note that these quantile-quantile plots are linear; care should be exercised when comparing these plots with similar ones presented with logarithmic axes.

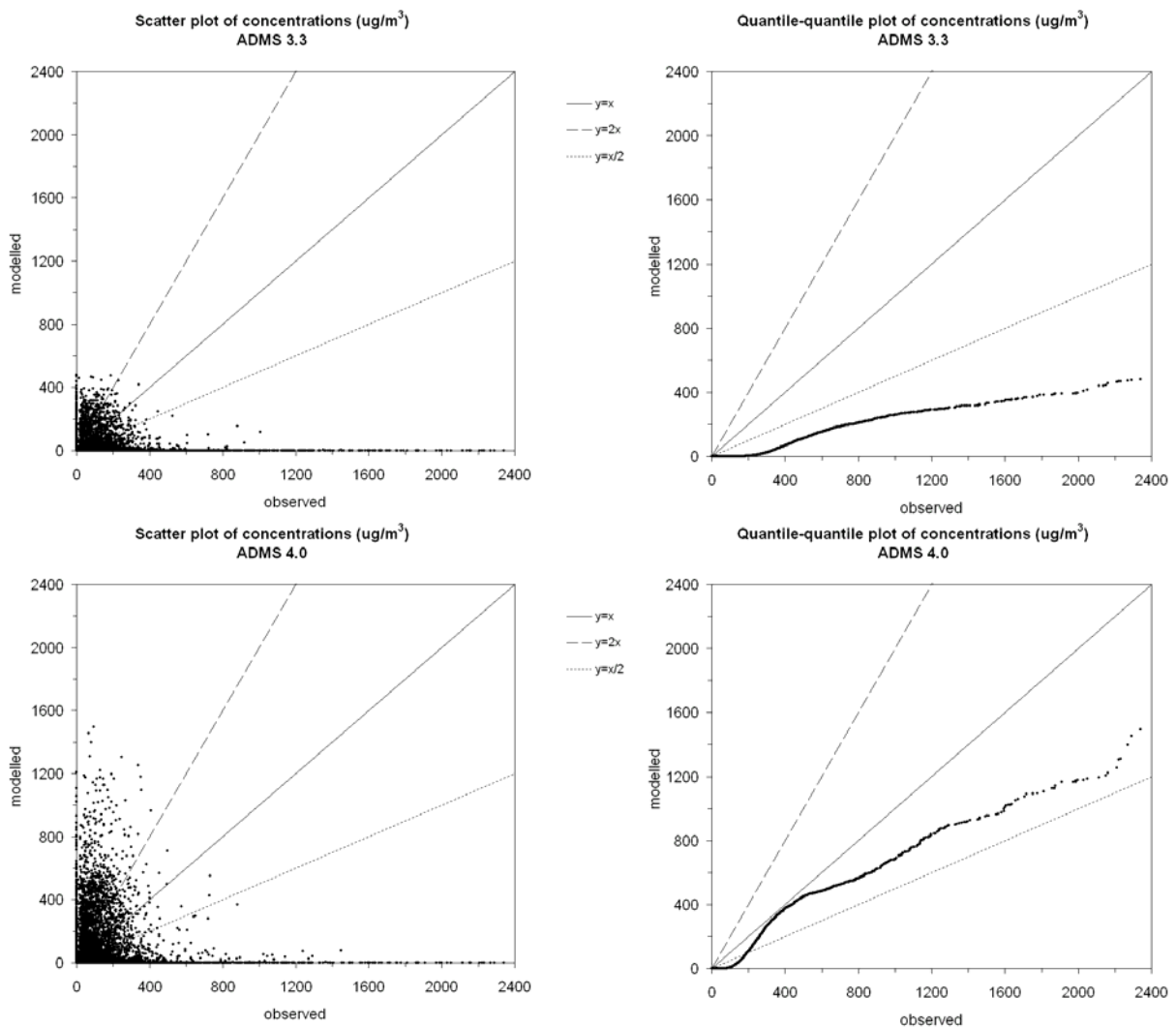


Figure 4 – Scatter plots and quantile-quantile plots of ADMS results against observed data (ug/m³).

3.2 Statistics

Table 3 compares the annual mean and maximum values at the receptor points.

Table 4 compares the robust highest concentrations.

Statistics	Data	Concentrations (ug/m ³)											Mean M/O ratio
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	
1-hour maximum	observed	1909	1191	1697	2290	2341	2269	2234	2210	1859	539	533	-
	ADMS 3.3	352	218	395	366	317	479	265	219	296	132	173	0.19
	observed	1909	496	1601	2290	2341	2269	2234	2210	1859	468	533	-
	ADMS 4.0	1311	711	1187	792	800	1495	402	337	326	258	676	0.59
3-hour maximum	observed	1418	397	1136	1195	1634	1380	1947	1361	1239	417	380	-
	ADMS 3.3	266	73	266	271	155	403	118	131	99	97	93	0.18
	observed	1418	241	1136	1195	1634	1380	1947	1361	1239	293	380	-
	ADMS 4.0	929	355	629	393	350	1192	159	153	118	150	273	0.51
24-hour maximum	observed	436	86	415	370	403	375	689	327	285	114	167	-
	ADMS 3.3	62	13	53	44	32	153	27	23	19	16	24	0.14
	observed	360	80	282	286	403	332	689	327	285	114	167	-
	ADMS 4.0	403	36	346	177	61	525	49	35	32	36	63	0.56
annual mean	observed	66.9	39.8	56.7	51.7	56.4	107.3	69.9	59.8	57.2	23.2	41.1	-
	ADMS 3.3	5.2	0.3	2.0	1.4	0.8	21.9	0.8	0.7	0.7	1.5	1.2	0.05
	observed	62.3	36.2	50.2	43.9	47.4	108.0	53.3	51.5	45.4	20.1	41.5	-
	ADMS 4.0	29.3	1.1	14.2	6.1	2.9	95.1	1.9	0.9	1.3	3.3	6.9	0.21

Table 3 – Observed (O) and modelled (M) maximum concentrations and annual mean (ug/m³) per receptor point, and the mean ratio of modelled/observed values for each statistic.

Data	1-hour	3-hour	24-hour
ADMS 3.3	0.20	0.23	0.27
ADMS 4.0	0.55	0.59	1.03

Table 4 – Ratio of modelled/observed robust highest concentrations (number of points = 26).

4 Discussion

The scatter and quantile-quantile plots shown in **Figure 4** show that results are significantly improved by the inclusion of a wind profile file for ADMS 4.0. In addition, ADMS 4.0 gives reasonable predictions for the maximum concentrations at each receptor (**Table 3**) and the robust highest concentration values (**Table 4**).

The only statistic that is not well modelled is the annual average, which is significantly underpredicted. One explanation for this may be the fact that no background concentrations of SO₂ have been included in the modelling.

5 References

- [1] Paine, R.J, Lee, R.F, Brode, R, Wilson, R.B, Cimorelli, A.J., Perry, S.G., Weil, J.C., Venkatram, A, and Peters, W., 1998: *Model Evaluation Results for AERMOD (draft)*. United States Environmental Protection Agency.
- [2] Strimaitis, D. G., R. J. Paine, B. A. Egan and R. J. Yamartino, 1987: *EPA Complex Terrain Model Development: Final Report*. Contract No. 68-02-3421, United States Environmental Protection Agency, Research Triangle Park, North Carolina.

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