

ADMS 4 Buildings & Complex Terrain Validation *Martins Creek Steam Electric Station*

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1 Introduction

The Martins Creek Steam Electric Station¹ [1] is located in a rural area along the Delaware River on the Pennsylvania/New Jersey border, approximately 30 km north-east of Allentown, PA and 95 km north of Philadelphia, PA.

The area can be characterised by complex terrain rising above the stacks. Sources included multiple tall stacks ranging from 122 to 183 m in height. The seven SO₂ monitors were located on Scotts Mountain which is about 2.5-8 km south-east of the Martins Creek facility.

On-site meteorological data covered the period from 1 May 1992 through 19 May 1993. Hourly temperature, wind speed and wind direction at 10 m were recorded from an instrumented tower located in a flat area approximately 2.5 km west of the plant. In addition, hourly multi-level wind measurements were taken by a SODAR located approximately 3 km south-west of the Martins Creek station.

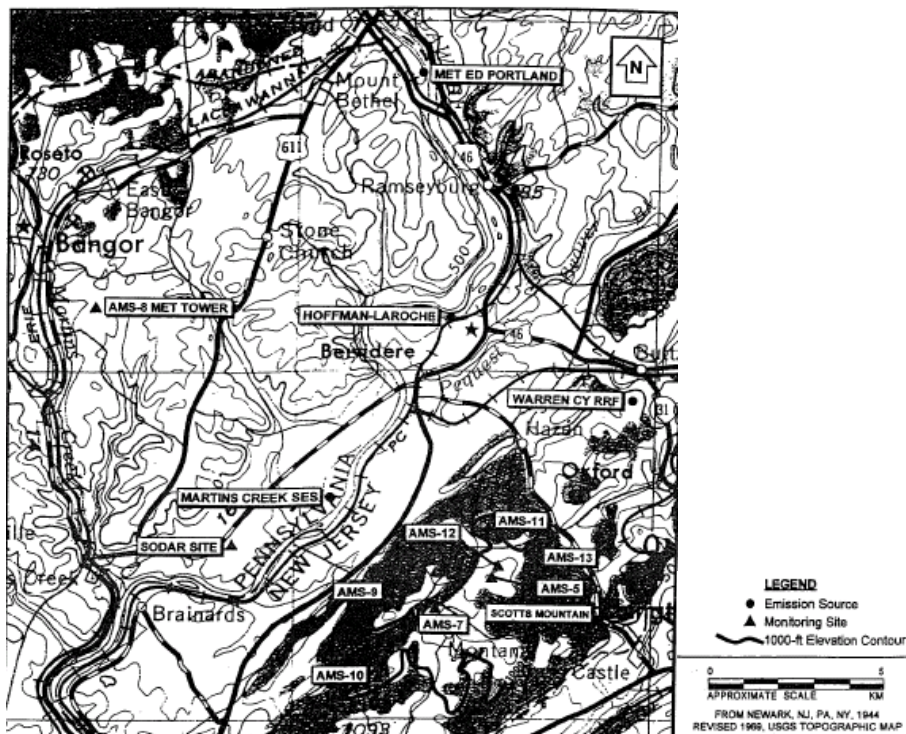


Figure 1 – Locations of monitors, meteorological stations and emissions sources.

¹ Note that the study description has been taken directly from the document [2] and **Figure 1** from the document [3].

Source name	Pollutant	Location	Stack height (m)	Exit V (m/s)	Exit T (°C)	Diameter (m)	Emission rate (g/s)
MC12	SO ₂	491010, 515910	182.9	varied	varied	5.3	varied
MC3	SO ₂	491123, 516030	182.9	varied	varied	6.9	varied
MC4	SO ₂	491190, 516068	182.9	varied	varied	6.9	varied
ED1	SO ₂	493350, 528370	121.9	varied	varied	3.1	varied
ED2	SO ₂	493350, 528370	121.9	varied	varied	3.6	varied
HL2	SO ₂	494050, 521040	67	varied	varied	2.7	varied
WC1	SO ₂	498950, 518500	64.9	varied	varied	1.87	varied
WC2	SO ₂	498950, 518500	64.9	varied	varied	1.87	varied

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

2.3 Receptors

Receptor name	Location
Point1	495041, 514049
Point2	494369, 513602
Point3	492801, 513876
Point4	492440, 511592
Point5	495232, 515616
Point6	495266, 514282
Point7	496497, 514701

Table 2 – Receptor point locations.

The receptor network consists of 10 points, ranging from 2 to 10 km from the sources. All receptors were modelled as ground level receptors. **Figure 2** shows the receptor network used in the experiment and **Table 2** summarises their locations.

2.4 Meteorological data

The experiment used just over one year of hourly sequential data from 1st May 1992 to 19th May 1993. **Table 3** gives the detail of the modelled meteorological conditions. The wind speeds at 90 m varied from 0.1 to 13.6 m/s and the ambient temperature from -17 to 32°C. The wind rose is shown in **Figure 3**. ADMS 4.0 also used the recorded wind at 10, 90, and every 30 m until 420 m above ground level, and the temperature at 10 m.

Conditions		ADMS 3.3	ADMS 4.0
Hours modelled	Stable conditions	4376 (59%)	4360 (59%)
	Neutral conditions	362 (5%)	362 (5%)
	Unstable conditions	2640 (36%)	2674 (36%)
	<i>Total</i>	<i>7378 (100%)</i>	<i>7396 (100%)</i>
Hours not modelled	Calm conditions	0	0
	Wind speed at 10 m < 0.75 m/s	1520	1502
	Inadequate data	318	318
	<i>Total</i>	<i>1838</i>	<i>1820</i>

Table 3 – Meteorological conditions. Percentage values are computed with respect to the total number of modelled hours.

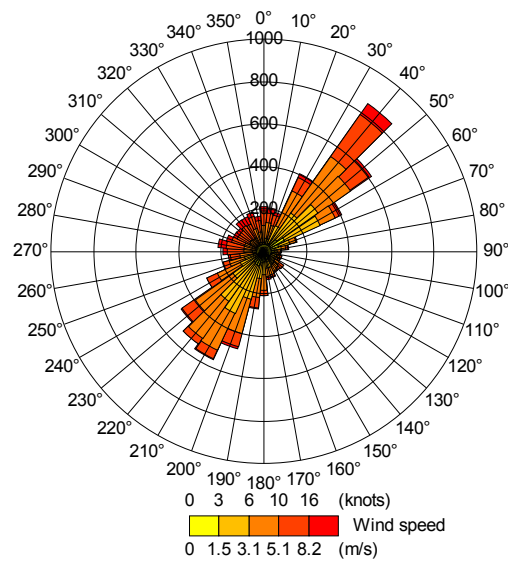


Figure 3 – Wind rose.

2.5 Buildings

The building dimensions are given in **Table 4**.

The building location relative to the modelled stacks is shown in **Figure 4**.

Building name	Length (m)	Width (m)	Height (m)	Angle (°)
CoolingT	180.2	90.4	90.0	63

Table 4 – Dimensions of the building.

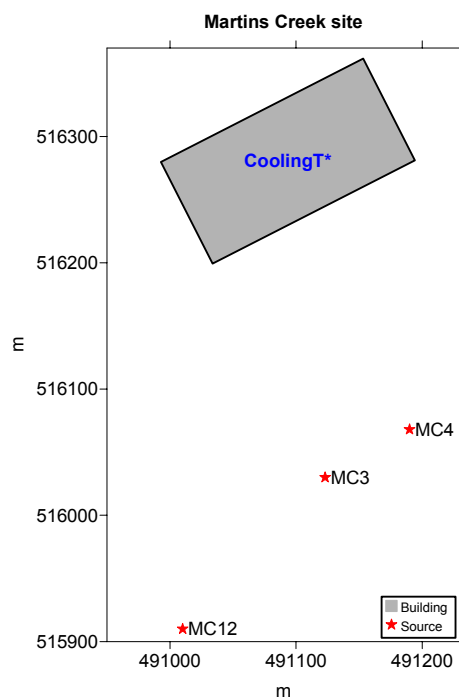


Figure 4 – The building location.

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

The modelled SO_2 concentrations are compared to observed hourly concentrations ($\mu\text{g}/\text{m}^3$). **Figure 5** shows the scatter plots and quantile-quantile plots of results. Note that these quantile-quantile plots are linear; care should be exercised when comparing these plots with similar ones presented with logarithmic axes.

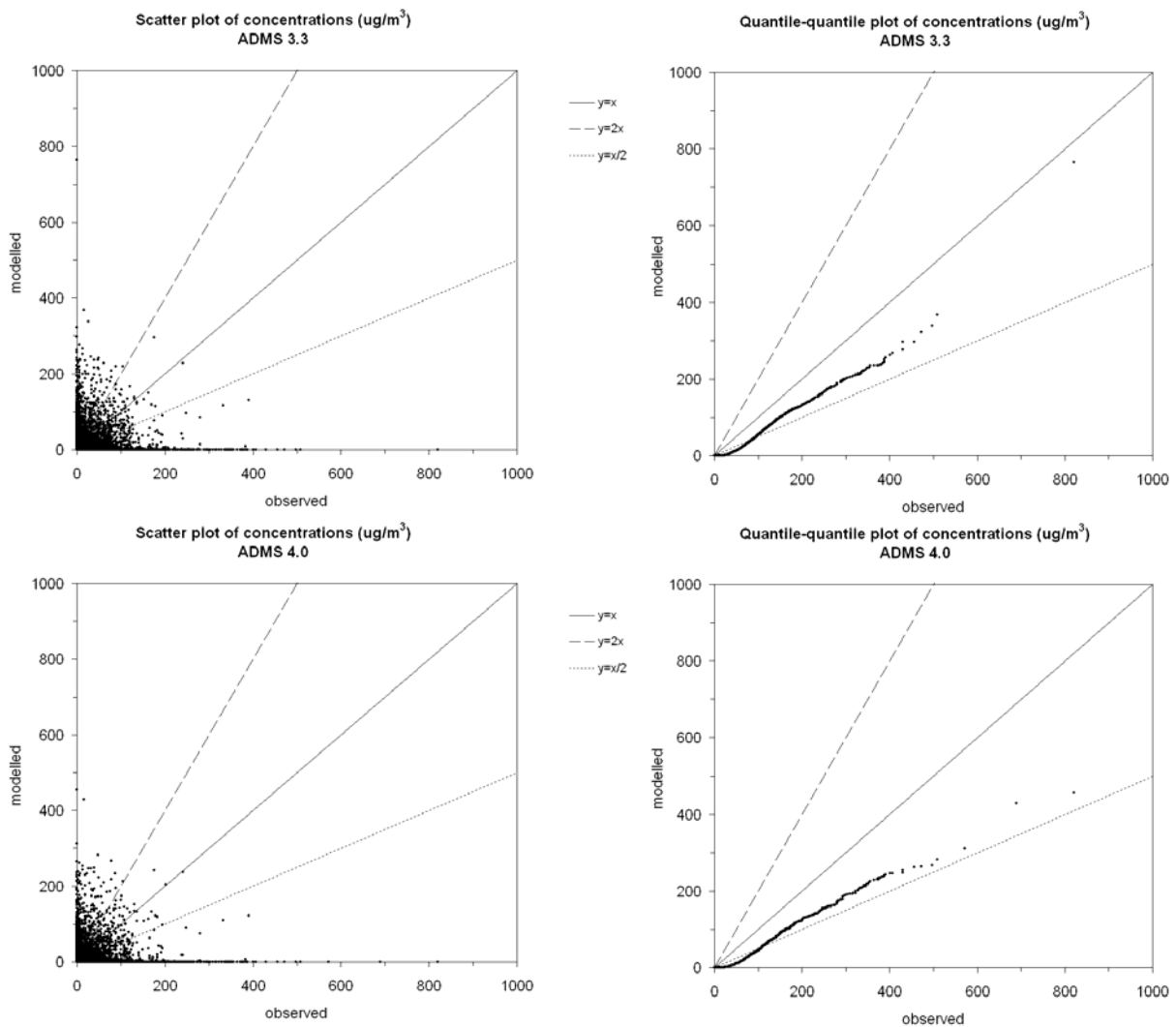


Figure 5 – Scatter plots and quantile-quantile plots of ADMS results against observed concentrations ($\mu\text{g}/\text{m}^3$).

3.2 Statistics

Table 5 compares the annual mean and maximum concentrations at each receptor point.

Table 6 compares the ratio of robust highest modelled/observed concentrations.

Statistics	Data	Concentrations (ug/m ³)							Mean M/O ratio
		P1	P2	P3	P4	P5	P6	P7	
1-hour maximum	observed	388	390	820	430	430	383	498	-
	ADMS 3.3	245	296	322	297	765	337	368	0.84
3-hour maximum	observed	388	571	820	689	430	383	498	-
	ADMS 4.0	282	243	265	312	455	267	430	0.65
24-hour maximum	observed	277	197	394	201	288	192	314	-
	ADMS 3.3	152	236	179	136	197	145	150	0.69
annual mean	observed	277	197	394	201	288	192	314	-
	ADMS 4.0	136	217	155	139	157	151	144	0.64
24-hour maximum	observed	73	119	185	107	60	101	90	-
	ADMS 3.3	50	56	38	33	48	44	34	0.47
annual mean	observed	73	119	185	107	60	101	90	-
	ADMS 4.0	47	49	34	31	46	42	34	0.44
annual mean	observed	11.5	12.1	15.7	11.7	10.0	13.3	12.2	-
	ADMS 3.3	2.8	2.7	3.3	3.4	3.5	2.8	3.2	0.26
annual mean	observed	11.5	12.2	15.9	11.9	9.7	13.2	12.0	-
	ADMS 4.0	2.5	2.4	2.7	3.1	2.9	2.5	2.9	0.22

Table 5 – 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	0.72	0.46	0.34
ADMS 4.0	0.56	0.40	0.34

Table 6 – Ratio of modelled/observed robust highest concentrations (number of points = 26).

4 Discussion

According to the AERMOD source files [4], the observed concentrations have been adjusted to account for background concentrations of SO₂. The method used to make this adjustment is not known. However, the statistics presented in **Table 5** still indicate that there may be some background unaccounted for because whilst the model gives relatively good predictions of the 1- and 3-hourly maximum values, the 24-hourly and mean concentrations are lower relative to the measured concentrations.

ADMS 4.0 modelled predictions of observed values are generally slightly lower than those of ADMS 3.3.

5 References

- [1] TRC, 1994: *Air Quality Model Performance Evaluation and Comparison Study for Martins Creek Steam Electric Station*. TRC Project No. 14715-R61. TRC Environmental Corporation, Windsor, CT.
- [2] United States Environmental Protection Agency, 2003: *AERMOD, Latest Features and Evaluation Results*. EPA-454/R-03-003.

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