ADMS 6 Buildings Validation
Alaska North Slope Tracer Study

Cambridge Environmental Research Consultants
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1 Introduction

The Alaska North Slope tracer study[1] (see **Figure 1**) involved 44 hours of buoyant SF_6 releases from a 39 m high turbine stack. Tracer sampler coverage ranged over seven arcs from 50 to 3000 m downwind.

Meteorological data, including wind speed, wind direction, temperature, sigma-theta and sigma-w, were available from an on-site tower at the 33 m level. Atmospheric stability and wind speed profiles were influenced by the smooth snow-covered tundra surface with negligible levels of solar radiation in the autumn months.

All experiments (44 usable hours) were conducted during the abbreviated day light hours (0900-1600). Wind speeds taken at the 33 m level during the tests were less than 6 m/s during one and part of another test, between 6 and 15 m/s during four tests, and in excess of 15 m/s during three tests.

The observed data were collected over 7 days: 23rd and 29th September 1987, 1st, 2nd, 4th, 7th, and 8th October 1987. Stability conditions were generally neutral or slightly stable.

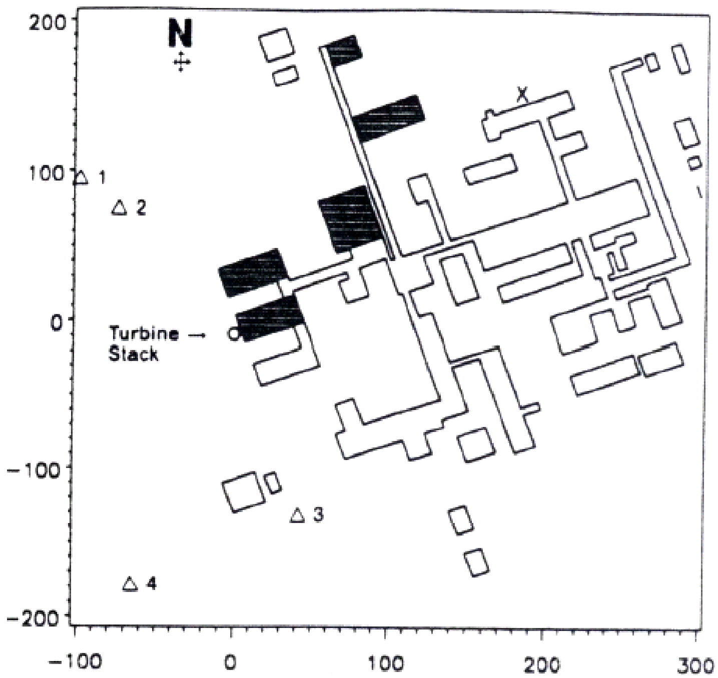

Figure 1 − Depiction of Alaska North Slope Oil Gathering Centre Turbine Stack, meteorological tower (X), and camera locations used to visualize plume rise.

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 arcwise maximum observed concentrations that have been used for comparison with the ADMS modelled concentrations.

This document compares the results of ADMS 5.2.0.0 (hereafter referred to as ADMS 5.2) with those of ADMS 6.0.0.1 (hereafter referred to as ADMS 6.0).

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

2.1 Study area

The latitude of the site is 70.3°N and the surface roughness was taken to be 0.01 m.

2.2 Source parameters

The source parameters are summarised in **Table 1**. Note that the 1 g/s emission rate indicates that the observed concentrations supplied in [2] have been normalised by the emission rate.

Source name	Pollutant	Location	Stack height (m)	Exit V (m/s)	Exit T (°C)	Diameter (m)	Emission rate (g/s)
STACK	SF_6	(0,0)	39.2	18.3	578.15	3.66	1

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

2.3 Receptors

The receptor network consisted of an arc arrangement of receptors. **Figure 2** shows where the receptors are located for the experiment. Receptor arcs are at distances of approximately 50, 150, 325, 500, 750, 950 and 2000-3000 m downwind of the stack.

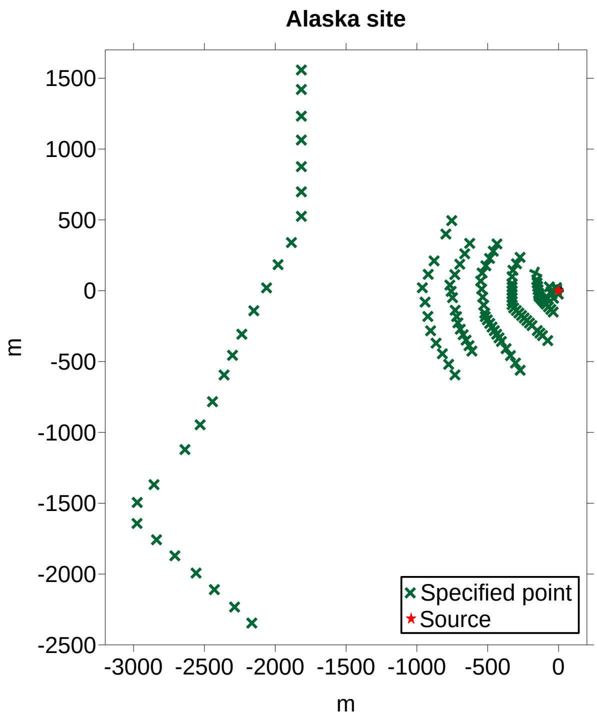

Figure 2 – The receptor network.

2.4 Meteorological data

The meteorological data, including wind speed, wind direction, temperature, sigma-theta (standard deviation of wind direction) and sigma-w (vertical turbulence velocity), were collected from an on-site tower at the 33-m level, over 7 days: 23rd and 29th September 1987, 1st, 2nd, 4th, 7th, and 8th October 1987. The meteorological conditions are summarized in **Table 2.** The criteria for the stability categories are as follows, where H is the boundary layer height and L_{MO} is the Monin-Obukhov length, as calculated by the model's meteorological processor:

Stable: $H/L_{MO} > 1$
Neutral: $-0.3 \leq H/L_{MO} \leq 1$
Convective: $H/L_{MO} < -0.3$

Conditions	ADMS 5.2	ADMS 6.0
Stable conditions	6	5
Neutral conditions	32	33
Unstable conditions	0	0
Total	*38*	*38*

Table 2 – Meteorological conditions.

The wind speeds varied from 3.0 to 18.4 m/s, the ambient temperature from -16.5 to -8.8°C and the wind direction between 19° and 112°.

2.5 Buildings

The building dimensions are given in **Table 3**. Their locations relative to the modelled stack are shown in **Figure 3**. It is interesting to note that whilst there are clearly more buildings on the site than the two depicted in **Figure 3**, [2] only gives details of those modelled in this study.

Building name	Length (m)	Width (m)	Height (m)
Building1	25.3	20.2	34.1
Building2	25.3	20.2	34.0

Table 3 – Dimensions of the buildings.

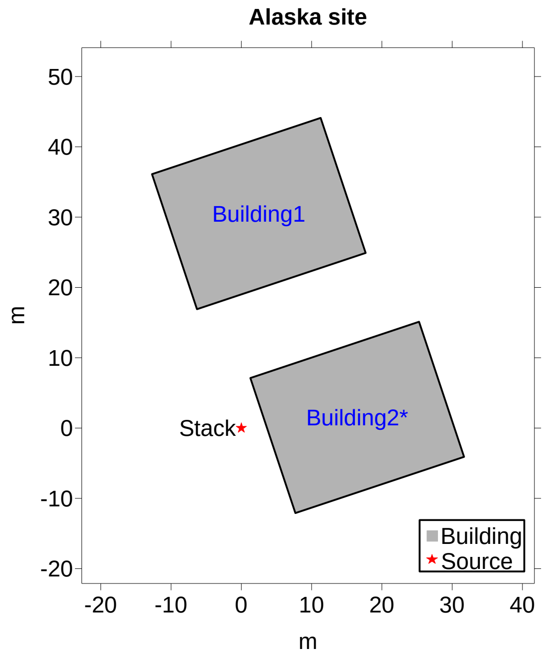

Figure 3 − The building and stack locations.

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. The graphs and statistical analysis have been produced by the Model Evaluation Toolkit v5.2 [3].

3.1 Scatter and quantile-quantile plots

Figure 4 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.

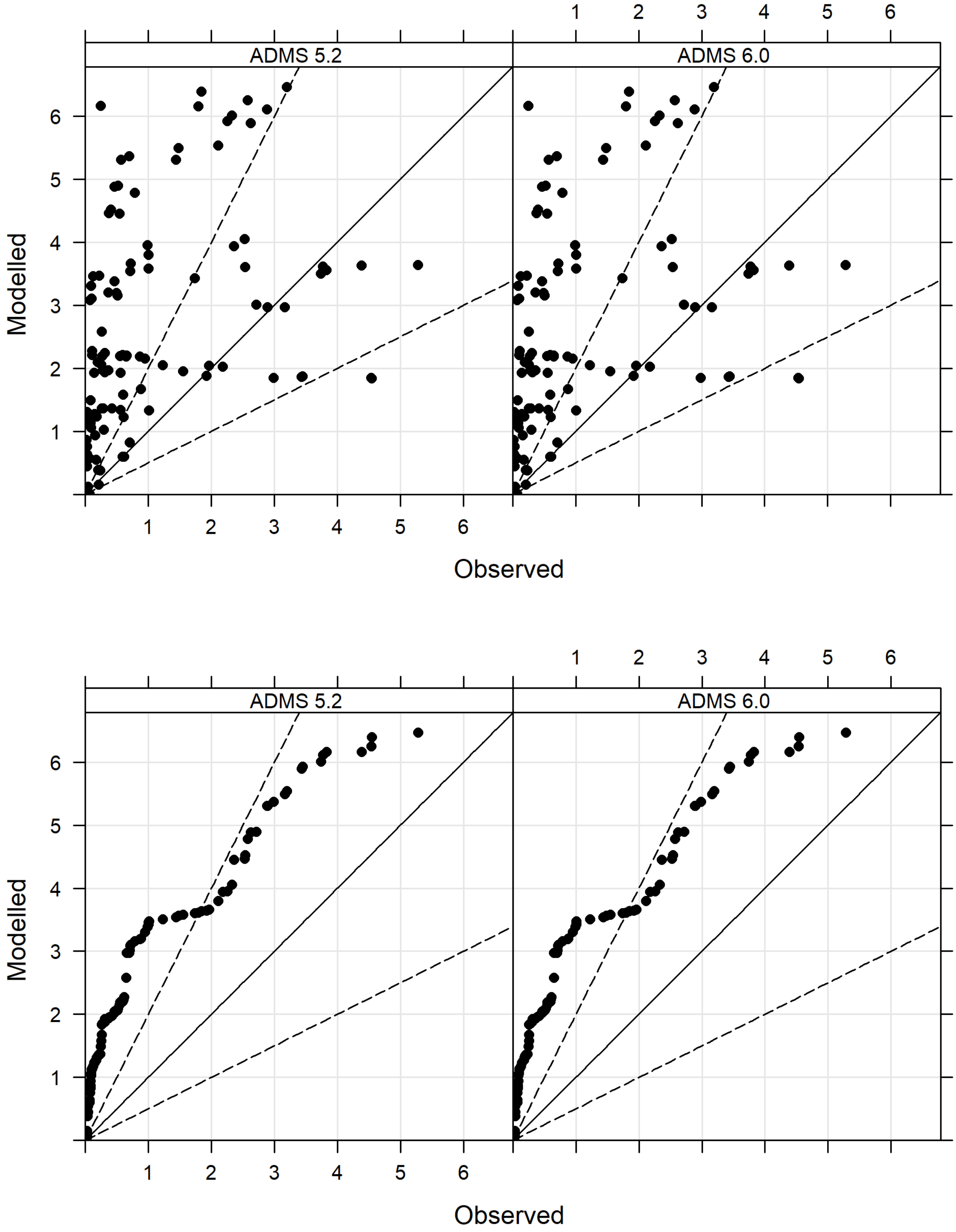

Figure 4 – Scatter plots and quantile-quantile plots of ADMS results against observed data (us/m^3).

3.2 Statistics

The Model Evaluation Toolkit 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).

Data	Mean	Sigma	Bias	NMSE	Cor	Fa2	Fb	Fs
Observed	0.78	1.16	0.00	0.00	1.000	1.000	0.000	0.000
ADMS 5.2	1.89	1.86	1.11	2.50	0.546	0.216	0.832	0.463
ADMS 6.0	1.89	1.86	1.11	2.50	0.545	0.216	0.832	0.463

Table 4 – Summary statistics.

4 Discussion

The scatter plots, quantile-quantile plots and statistics all indicate that ADMS over-predicts the observed concentrations. The correlation between modelled and observed values is reasonable (0.55).

There are only marginal differences between ADMS 5.2 and ADMS 6.0. The ADMS 6.0 buildings code developments relating to how plumes that directly impact a building are modelled as well as how the ground-level plume downwind of the recirculation region is modelled are unlikely to have a large effect in this study due to the relative height of the source compared with the buildings.

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*. https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models

[3] Stidworthy A, Carruthers D, Stocker J, Balis D, Katragkou E, and Kukkonen J, 2013: *MyAir Toolkit for Model Evaluation*. 15th International Conference on Harmonisation, Madrid, Spain, May 2013.

[4] Thunis P., E. Georgieva, S. Galmarini, 2010: *A procedure for air quality models benchmarking*. https://fairmode.jrc.ec.europa.eu/document/fairmode/WG1/WG2_SG4_benchmarking_V2.pdf

[5] David Carslaw and Karl Ropkins (2011). *openair: Open-source tools for the analysis of air pollution data*. R package version 0.4-7. http://www.openair-project.org/

[6] Chang, J. and Hanna, S, 2004: *Air quality model performance evaluation*. Meteorol. Atmos. Phys. **87**, 167-196.