# ADMS 5 Buildings Validation
# *Alaska North Slope Tracer Study*

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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.

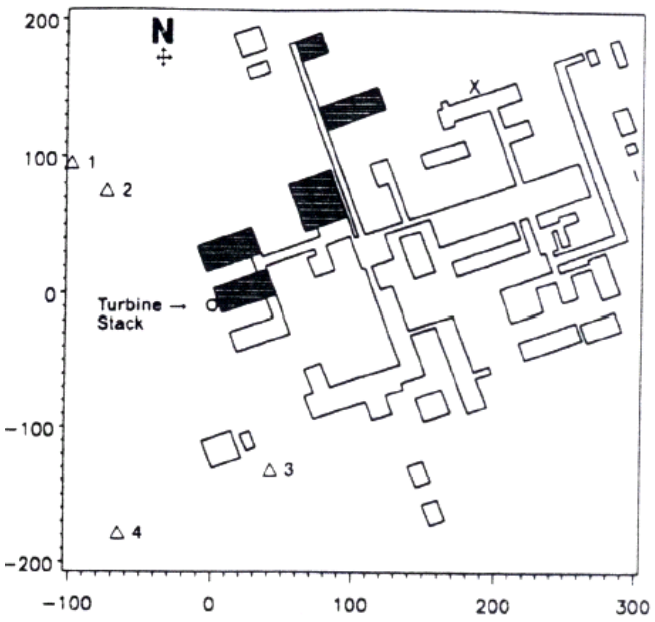


**Figure 1** − Depiction of Alaska North Slope Oil Gathering Centre Turbine Stack, meteorological tower (X), and camera locations used to visualize plume rise.

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 5.1.2.0 (hereafter referred to as ADMS 5.1) with those of ADMS 5.2.0.0 (hereafter referred to as ADMS 5.2).

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.

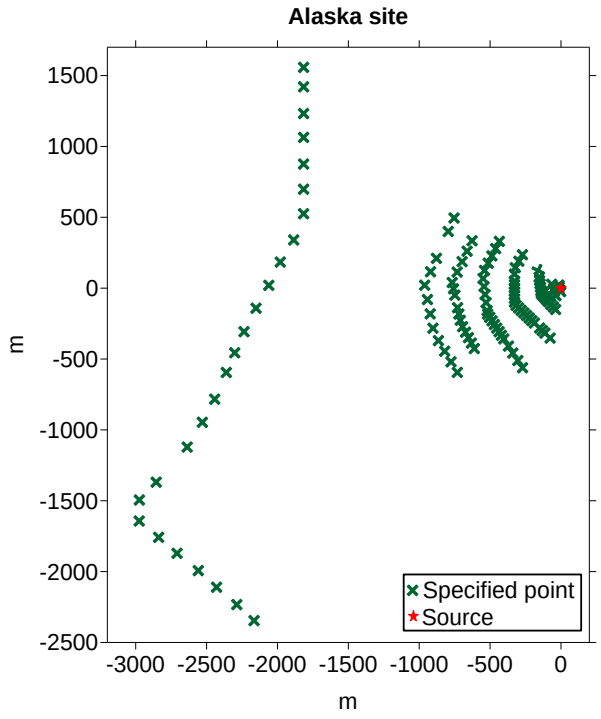


**Figure 2** − The receptor network.

## 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. During the experiment there were 6 stable conditions and 32 neutral 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 2**. 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 2** – Dimensions of the buildings.

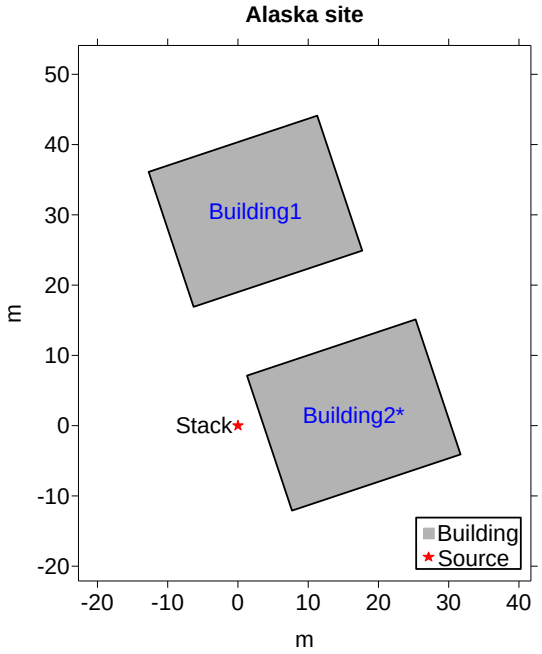


**Figure 3** – The building and stack locations.

## 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 MyAir Toolkit for Model Evaluation [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.

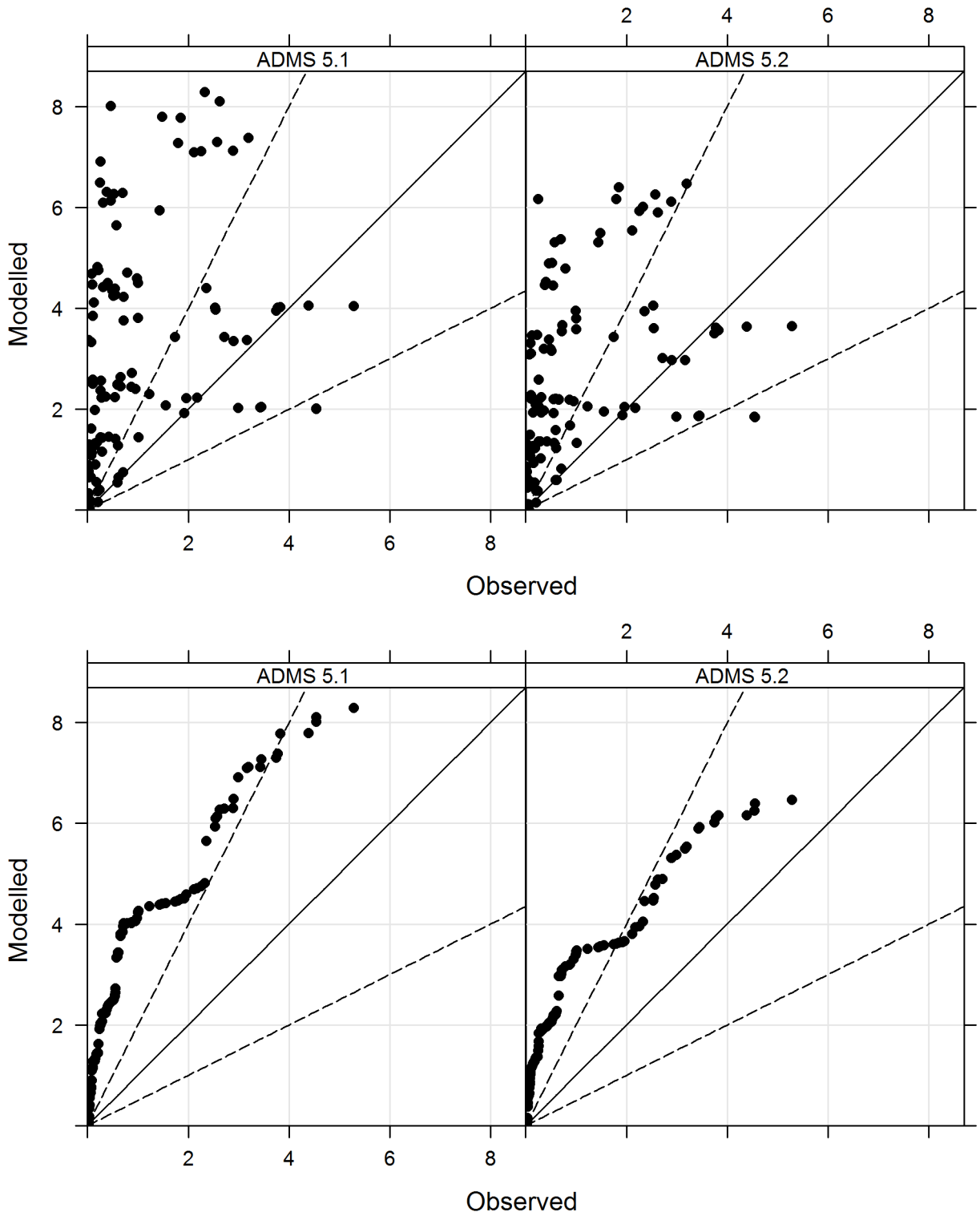


**Figure 4** − Scatter plots and quantile-quantile plots of ADMS results against observed data (us/m$^3$).

## 3.2 Statistics

The MyAir 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). Note that the sign of the bias and fractional bias calculated by the Myair Toolkit is consistent with openair [5] and the DELTA tool [4], but not with the BOOT package [6]. **Table 3** shows such results for all runs.

| 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 5.1 | 2.35 | 2.36 | 1.57 | 3.71 | 0.470 | 0.235 | 1.001 | 0.681 |
| ADMS 5.2 | 1.89 | 1.86 | 1.11 | 2.50 | 0.546 | 0.216 | 0.832 | 0.463 |

**Table 3** – Summary statistics.

## 4 Discussion

The ADMS 5.2 modelled concentrations show an improvement over ADMS 5.1 for this study.

The scatter, quantile-quantile and statistics all indicate that ADMS over-predicts the observed concentrations, although the over-prediction of the highest concentrations has reduced due to the model changes. In addition, the correlation between modelled and observed values is reasonable (0.55).

## 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

[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*. http://fairmode.ew.eea.europa.eu/fol568175/work-groups

[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.