1.32 MODEL INTERCOMPARISON BETWEEN ADMS 3.1, AERMOD AND AERMOD PRIME

Christopher Sidle, Bethan Tuckett-Jones, Betty Ng and Ji Ping Shi*
Air Quality Modelling and Assessment Unit (AQMAU), Environment Agency, 29 Newport Road, Cardiff CF24 0TP UK. *Corresponding author

INTRODUCTION

A suite of tests have been built up over time to develop a model intercomparison protocol to aid the Environment Agency in assessing the regulatory implications of the release of new models or model versions. The Environment Agency has conducted a model intercomparison study of AERMOD (99211), AERMOD Prime (02091) and ADMS 3.1. The aim of this study was to inform on the regulatory implications of the use of these models. The study investigated the model calculations of plume rise, building entrainment and the plume interaction with terrain. The models were run to generate annual mean ground level concentrations and annual percentile statistics of hourly mean ground level concentrations. In addition, they were run to examine the model responses under meteorological conditions representative of neutral conditions, unstable and stable conditions.

A selection of the results and the main conclusions are presented here. Detailed reports (AQMAU 2002a,b,c, & d) and model input files are available from the website:
"http://www.environment-agency.gov.uk/subjects/airquality/236092/239033/?lang=_e"

Flat Terrain

The stack discharge conditions used in the test cases presented here are listed in Table 1.

Table 2 shows the maximum annual mean ground level concentration output by the models for the cases of 40m and 150m stack discharges, with and without buoyancy in flat terrain. The maximum in the grid and the spatial distributions of the 98th percentiles from different models agree better with one another than those for the 99.9th and 100th percentiles.

Table 1. Stack discharge conditions used in the basic model tests for flat terrain, for a buildings test case and for a complex terrain test case.

	40m stack		150m stack		65m stack	122m stack
	No buoyancy	With buoyancy	No buoyancy	With buoyancy	Used in building test cases only	Used in terrain test case only
Stack Diameter (m)	1	1	1	4	5.8	3.66
Temperature (°C)	15	130	15	130	137	165
Exit Velocity (m/s)	5	25	5	25	24.45	8.34
Emission Rate (g/s)	1000	1000	1000	1000	100	1

Table 2. Maximum annual mean, 100th, 99.9th and 98th percentile ground level concentrations for the four basic test cases. The distance from source to maximum is given in metres; concentration is given in mg/m^3.

Run Details	Model	Mean		100 %ile		99.9 %ile		98.0 %ile	
		Dist.	**Conc.**	**Dist.**	**Conc.**	**Dist.**	**Conc.**	**Dist.**	**Conc.**
40m, no buoyancy	AERMOD	320	0.66	140	63.9	140	36	280	10.7
	AERMOD PRIME	320	0.63	200	41.8	140	24.8	280	9.5
	ADMS 3.1	420	0.69	360	167.0	100	65.7	280	9.7
40m, buoyancy	AERMOD	540	0.21	280	6.9	200	5.3	420	3.0
	AERMOD PRIME	540	0.20	320	4.7	320	4.1	540	2.8
	ADMS 3.1	540	0.24	200	10.9	220	8.4	540	3.2
150m, no buoyancy	AERMOD	850	0.06	450	9.1	450	3.8	850	1.0
	AERMOD PRIME	850	0.05	820	7.7	560	3.2	850	0.9
	ADMS 3.1	1130	0.03	280	9.7	400	5.2	1280	0.6
150m, buoyancy	AERMOD	1900	0.008	1400	0.7	1850	0.3	1900	0.2
	AERMOD PRIME	1900	0.008	2600	0.4	2840	0.3	1900	0.1
	ADMS 3.1	2720	0.005	1020	0.4	1340	0.3	3100	0.1

Buildings

A range of building test cases were performed to compare the models, but few generic conclusions could be made. A few results of interest are presented here. Figure 3 shows the different sensitivity of AERMOD PRIME and ADMS 3.1 to the wind angle, for neutral conditions for a 35m cube building, with the stack configured relative to the building as shown in figure 1. Stack discharge conditions are shown in table 1 for a 40m stack with non-buoyant emissions.

Table 3 shows the results for a test case for a single 65m stack with buoyant emissions and three 40m high buildings configured as in figure 2. ADMS 3.1 requires the choice of a main building to be made, the consequences of which are shown in table 3. It was also found that by altering the position of the stack relative to the three buildings, a point could be found where moving the stack by 1m altered significantly the AERMOD PRIME results, as shown in figure 4.

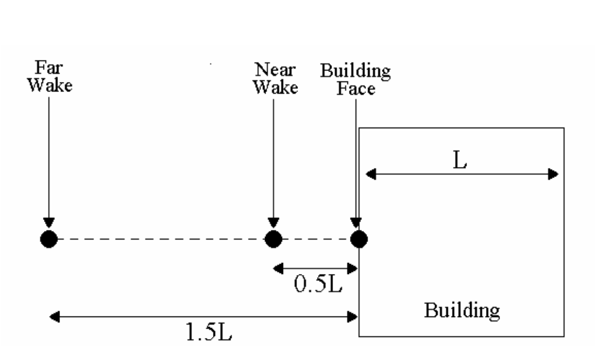


Figure 1. Configuration of stacks and building for results presented in figure 3.

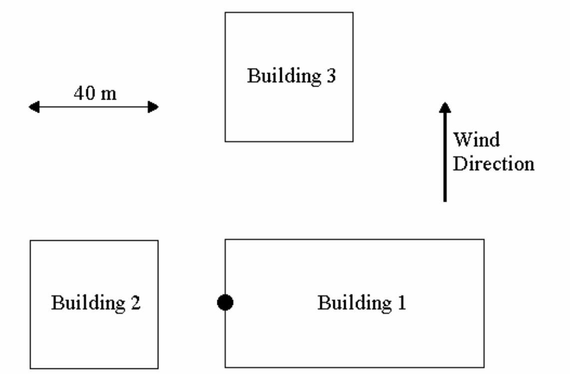
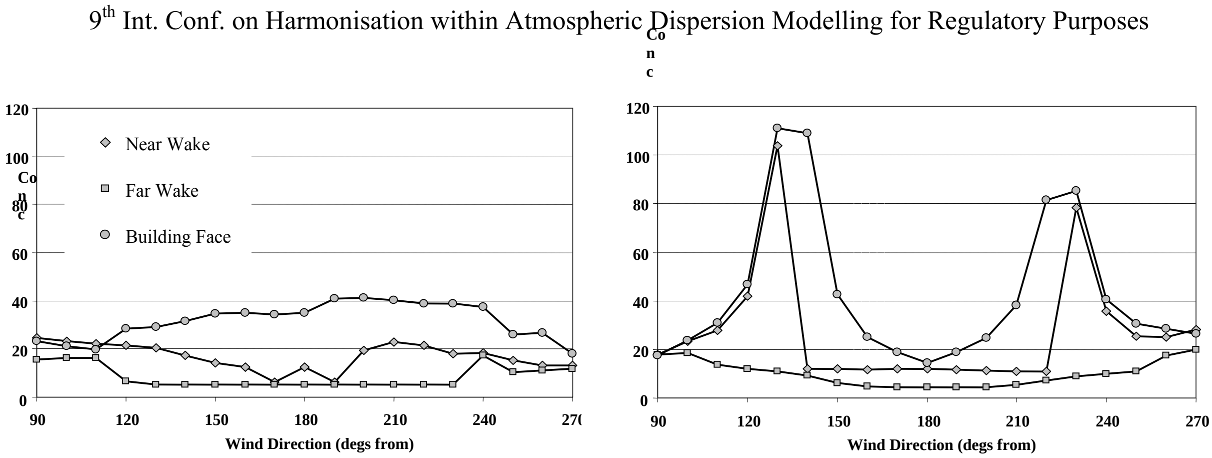


Figure 2. Configuration of stack and buildings for results presented in Table 3.



AERMOD PRIME **ADMS 3.1**

Figure 3. Maximum ground level concentrations in mg/m^3 as a function of wind direction for the AERMOD PRIME (Left) and ADMS 3.1 (Right) with a 40m stack with non-buoyant emissions located at the building face, in the near wake or in the far wake.

Table 3. Maximum ground level concentrations, in μgm^{-3}, and distance to maximum, in metres, for the test case shown in figure 2, for a 65m stack.

Run Details	ADMS 3.1	
	Dist.	Conc.
All 3 Buildings: Building 1 as main building	440	192
All 3 Buildings: Building 2 as main building	600	148
All 3 Buildings: Building 3 as main building	960	77

Run Details	AERMOD		AERMOD PRIME	
	Dist.	Conc.	Dist.	Conc.
All 3 Buildings	400	43.5	3400	16.9
Building 1 only	400	43.5	600	71.1
Building 2 or 3 only	400	43.5	3400	16.9

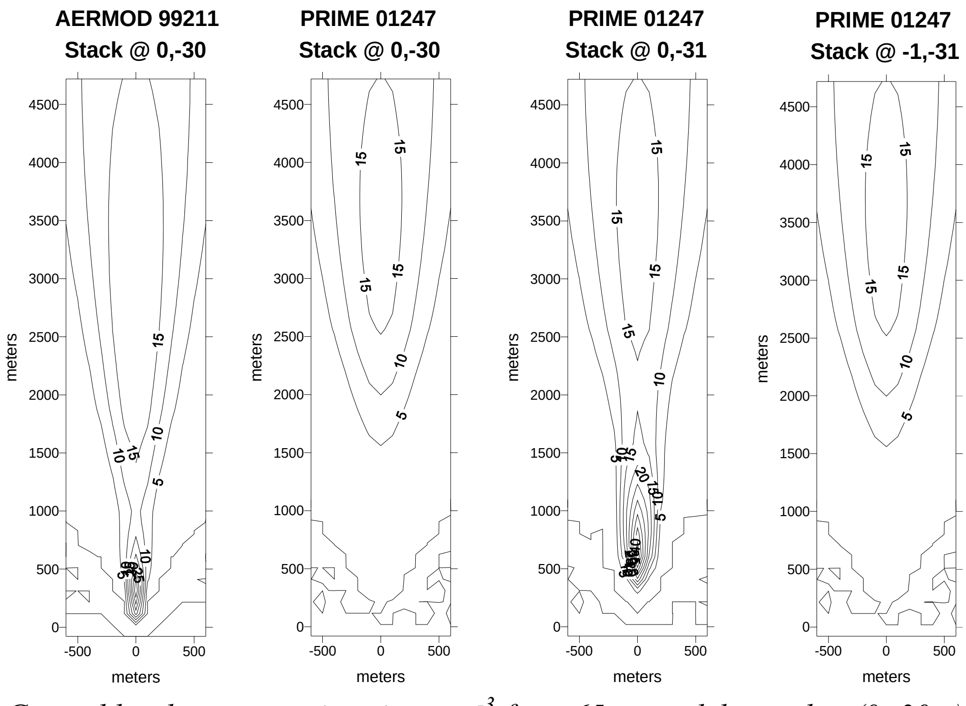


Figure 4. Ground level concentrations in $\mu g\ m^{-3}$ for a 65 m stack located at (0,-30m), (0,-31m) and (-1m,-31m) relative to its location presented in figure 2. All buildings are present.

Complex Terrain

A case study comparing the predictions of ADMS 3.1, AERMOD and AERMOD PRIME in complex terrain was carried out for a 122 metre stack (see table 1 for stack discharge conditions). Figure 5 shows the terrain contours in the modelling domain. Figure 6 displays contour plots for the annual mean and 99.9th percentile results for the three models.

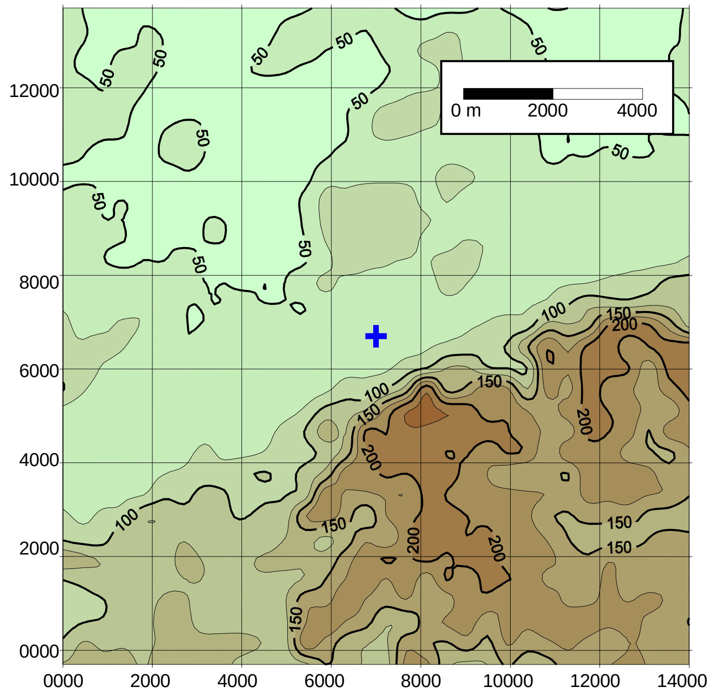


Figure 5. Terrain contours near the point source (shown by the cross).

CONCLUSIONS

Whilst significant differences exist between the model predictions, the study found that few generic conclusions could be reached regarding the implications for the use of the models. AERMOD Prime and ADMS 3.1 show significantly different dependence of building downwash effects on wind directions. There is no simple relationship between the predictions with building effects of AERMOD Prime and ADMS 3.1 over a range of building geometry. With terrain, AERMOD and AERMOD Prime give similar predictions. However, these results are very different from those of ADMS 3.1 in both spatial distribution and magnitude. In unstable conditions, AERMOD Prime predicts lower concentrations than either AERMOD or ADMS 3.1. For regulatory purposes it is therefore useful to make use of two models to gain or lose confidence in the modelled predictions. However model comparison alone cannot determine, for any specific case study, which model is performing better. Hence the value of performing comparison against measurements or wind tunnel data where feasible and appropriate. Therefore we would encourage further measurement campaigns or validation experiments to be performed to try to address the issues raised by model comparison studies.

REFERENCES

AQMAU (2002a) "An intercomparison of AERMOD, AERMOD PRIME and ADMS 3.1".

AQMAU (2002b) "Addendum to 'An intercomparison of AERMOD, AERMOD PRIME and ADMS 3.1"

AQMAU (2002c) "A comparison of ADMS 3.0 and 3.1".

AQMAU (2002d) "Addendum 1 to 'A comparison of ADMS 3.0 and 3.1"

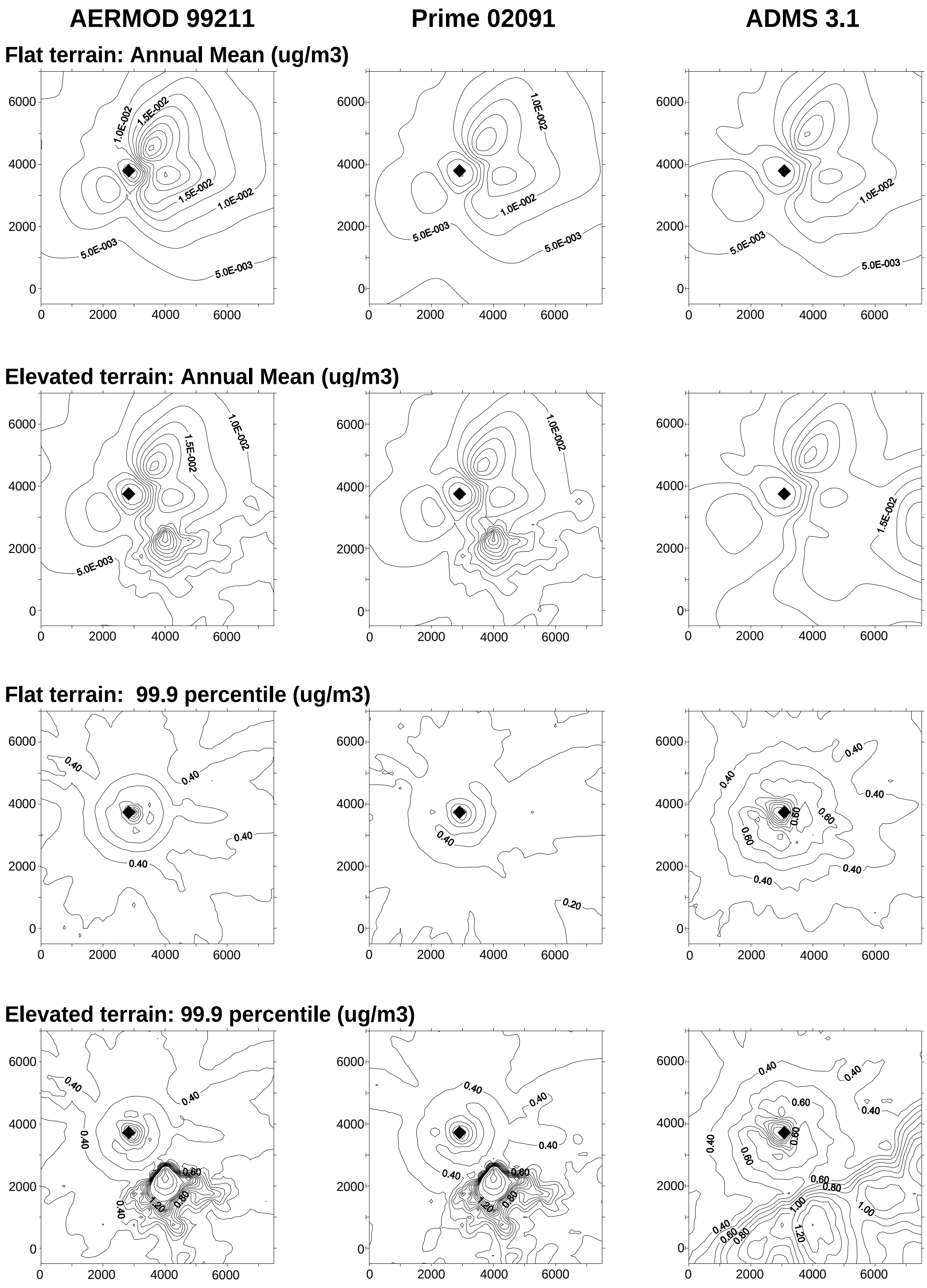


Figure 6. Annual mean and 99.9th percentile of hourly mean ground level concentrations in μg m⁻³ for the complex terrain test case. The location of the stack is shown by a black diamond. Horizontal distances are given in metres.