ADMS & CALPUFF INTER-MODEL COMPARISON WITH MM5 DATA

Victor von Reiche

Airshed Planning Professionals (Pty) Ltd

Introduction

An inter-model comparison of ADMS 4 and Calpuff was undertaken for SO_2 emissions from two tall stacks in a near field application (15 km x 15 km).

ADMS 4 is a new generation Gaussian plume air dispersion model, which characterises the atmospheric boundary layer properties by two parameters :

- the boundary layer depth, and
- the Monin-Obukhov length

Calpuff is a non-steady state Lagrangian Gaussian puff air dispersion model, which uses the CALMET meteorological model as input. The Calmet model includes a diagnostic wind field generator which generates hourly gridded micrometeorological parameters and three dimensional wind and temperature fields.

Various meteorological input configurations were tested in the ADMS model to determine if predicted ground level concentrations were comparable to the Calpuff model.

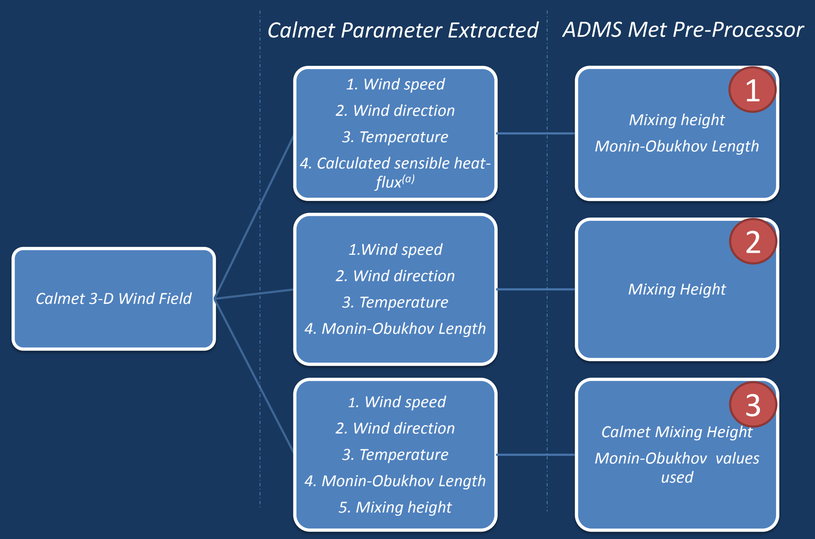
Methodology

MM5 prognostic data was obtained for the study area due to absence of local surface data.The Calmet model was setup with MM5 data for the study area.Ground level concentrations were simulated using the Calpuff model. The maximum number of puffs per time interval was used to maximise difference between puff and plume model.

A single Calmet surface grid point extracted for use in ADMS model. The ADMS model requires as a minimum the following any one input in addition to wind speed, wind direction and temperature:

- C loud cover, and/or
- Sensible surface heat flux, and/or
- Reciprocal Monin-Obukhov length

Different meteorological configurations were tested in ADMS as shown below:

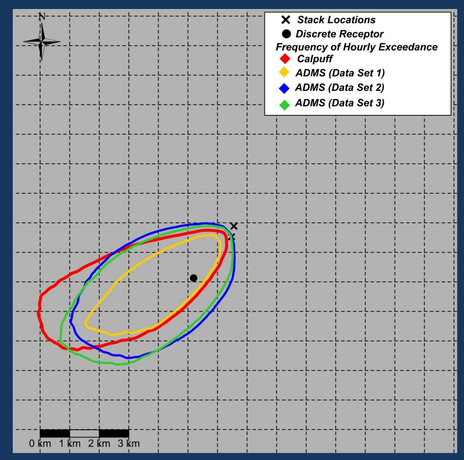


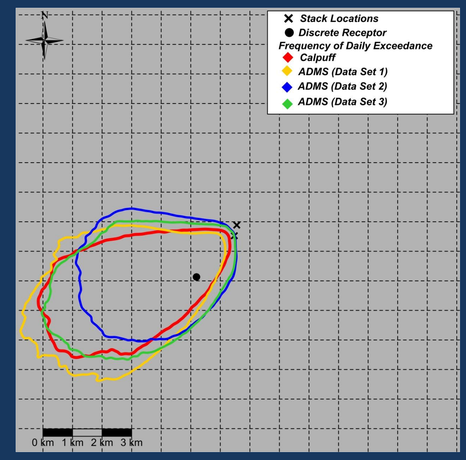
Note:

(a) Sensible heat flux calculated by in-house model based on heat-flux method (De Bruin and Holtslag, 1982)

Graphical comparison of frequency of hourly and daily exceedance for different configurations. Time-series analysis of single discrete receptor point ~2 km down-wind of plant.

Results





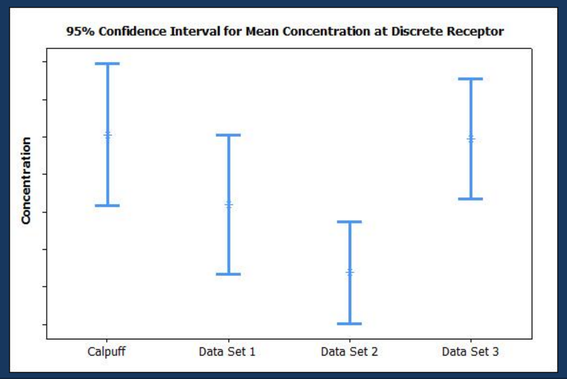
Time-Series

Time series analysis was done for a discrete receptor point 2 km downwind of the plant. The Index of Agreement (IOA) was determined as well as mean annual concentrations (95% confidence interval) for all three data sets. The IOA is given by:

Index of Agreement

$$\mathrm{IOA} = 1 - \frac{\sum_{i=1}^{N} (P_i - O_i)^2}{\sum_{i=1}^{N} \left(|P_i - O_{\mathrm{mean}}| + |O_i - O_{\mathrm{mean}}| \right)^2}.$$

Index of Agreement (IOA)	Data Set 1	Data Set 2	Data Set 3
Calpuff	0.897	0.821	0.861



Conclusion

ADMS predicted ground level concentrations, for all three data sets, were found to be very comparable to Calpuff predicted ground level concentrations as is evidenced by:

- Extend of predicted hourly and daily frequency of exceedance plots.
- High Index of Agreement (An IOA of 1 would show perfect agreement and an IOA of 0 would show no agreement).
- Comparable mean annual concentrations (95% confidence interval).

The ADMS model offers the user great flexibility with mixing height and Monin-Obukhov variables that can be input in the raw meteorological file directly or calculated by ADMS' met pre-processor from other variables, i.e. sensible heat flux.

References

de Bruin, H., and A. Holtslag, 1982: A simple parameterization of the surface fluxes of sensible and latent heat during daytime compared with the Penman–Monteith concept. J. Appl. Meteor.,21, 1610–1621.