Guidance notes for using the regulatory air pollution model AERMOD in Victoria

1.   Introduction

Schedule C of the State Environment Protection Policy - Air Quality Management (SEPP (AQM)) sets out the minimum requirements for modelling emissions to air and includes specification of the currently approved regulatory model.

The Environment Protection Authority (EPA) of Victoria has approved the US EPA regulatory air dispersion model AERMOD as the replacement for AUSPLUME as the approved regulatory air model for impact assessments in Victoria.

This guideline provides information on the recommended use of AERMOD and is to be used in conjunction with Schedule C of the SEPP (AQM), with the latest version of AERMOD now specified as the currently approved regulatory model.

AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain, with the modelling system comprising three components:

- AERMOD (dispersion model).
- AERMET (meteorological pre-processor).
- AERMAP (terrain pre-processor).

The basic source and executable codes for the latest approved version of AERMOD (currently version 12345 as of June 2013) and its component pre-processors can be downloaded, at no cost, from the USEPA web site, however, 'commercial' versions are also available (see Section 10 below).

Note that AERMOD is not static and evolves to accommodate the best available science. As such, it is the responsibility of the user to ensure that the latest approved version is used.

2.   Meteorological input files

Meteorology is one of the crucial inputs to air dispersion models. Preparation of this key input (data) needs to be done following recognised and accepted procedures.

AERMOD requires the input of two meteorological files; a 'surface' data file and a 'profile' data file. In the USA, these files are typically provided by the AERMET meteorological pre-processor; however, the use of AERMET is not suitable for standard use outside the USA in its current form due to the very 'USA-specific' nature of the basic input requirements.

The guideline document 'Construction of Input Meteorological Data Files for Regulatory Air Model (AERMOD)' describes the methods to be used in the construction of the AERMOD meteorological input data files when using AERMOD for air impact assessments in Victoria (EPA Victoria Publication No XXXX).

Note that the meteorological input files are required to contain recent five (5) sequential years of hourly data.

3.   Choice of modelling domain

In addition to the requirements listed in Schedule C (Part B No. 5) of the SEPP (AQM), EPA Victoria recommends the use of a uniform Cartesian grid with the following characteristics:

- A domain size (centred on the emission sources) of up to 10 km for flat terrain, and up to 5 km for elevated terrain[1].
- A grid spacing resolution chosen so that the maximum concentration is not significantly underestimated, and not greater than 50 m.

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1   Terrain heights equal to or less than the effective height of the emission exit point (for point sources).

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4.   Terrain input files

AERMOD is designed to calculate air pollutant concentrations in all types of terrain, from flat to complex terrain situations, with the AERMAP pre-processor designed to process several types of 'standardised' terrain data to produce terrain elevations for each receptor and source, and a receptor 'hill height scale' for use in complex terrain.

The AERMAP pre-processor is very 'USA-specific' in terms of the types of 'standardised' terrain data sources it processes, with the current version supporting processing of US Geological Survey (USGS) Digital Elevation
Model (DEM) data, and data from the National Elevation Dataset (NED) in the GeoTIFF format.

SRTM elevations represent the height of the 'reflective surface' for the radar signal, and therefore include the heights of obstacles such as building and trees. There are also data gaps in SRTM data due to the nature of radar reflectivity measurements.

Note that:

- The One-second DEM Project (http://www.csiro.au/science/One-second-SRTM-Digital-Elevation-Terrain-Model.html) being undertaken by CSIRO and BoM is currently developing one-second (30m resolution) DEM of Australia based on SRTM data.
- Gap filled and filtered (vegetation and obstacles removed) topography data in high resolution is available from Geo Science, Australia.

5.   Prediction of 3-minute average concentrations

The basic output from AERMOD is a 1-hour average concentration prediction that is determined using lateral dispersion values for a 1-hour average.

In view of the practical requirement that the approved USEPA version of the AERMOD source code not be modified, 3-minute average predictions need to be based on post-processing of the basic 1-hour average predictions. As such, use of the following formula for converting the 1-hour average concentrations to 3-minute values is recommended:

- $c(t) = c(t_0) \, (t_0/t)^{0.2}$,
- where (t) is the averaging time (minutes) of interest (3 minutes in this case), and (t_0) is the averaging time consistent with the dispersion rates (60 minutes in this case).

Note that this method may be s subject to change in the future.

6.   Modelling of area sources

It is recognised that AERMOD concentration predictions for area sources in the current approved version of AERMOD are likely to be overestimated under very light wind conditions (i.e. for wind speeds less than 1 m/sec). This issue is addressed in Section 6.2 of the AERMOD Implementation Guide – Last Revised March 19, 2009[2] with various options recommended for avoiding overestimates during such wind conditions. Note that the US EPA intend to develop a version of AERMOD to correct this problem.

EPA Victoria recommends that the interim USEPA approach be adopted until further notice with a volume source approximation used for cases when the key receptors are sufficiently distant from the source.

7.   Rural vs urban mode

AERMOD includes an option for incorporating the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions. Only the use of the Rural mode is approved by EPA Victoria at this stage.

8.   Choice of other options

The following options should not be used without specific approval by EPA Victoria:

- OLM and PVMRM option for modelling conversion of NOX to NO2.
- Dry and wet particle deposition options.
- Capped stacks and horizontal sources option.
- Open pit source option.
- Air toxics option.
- Screening mode.

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2 (http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod)

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9.   Selection of aermod outputs

The output options in AERMOD should be selected to produce the following in order to assess the impact of emissions to air as specified in Schedule C (Part C) of SEPP (AQM):

- The 'top 100 table' of the model results
- 9th highest (99.9 percentile) concentration files (Plot files) for pollutants having an averaging time of 1 hour or less (see Section 5 for post-processing to produce 3-minute average predictions).
- Highest (100 percentile) concentration files (Plot files) for pollutants having an averaging time of greater than 1 hour).

The following electronic output files should be submitted to, or available to, EPA Victoria:

- Model log file – AERMOD.out.
- Rank file including top 100 predicted values.
- Plot files (.plt) containing the highest and 9th highest predicted values.
- Exceedance files (frequency of exceedances) – optional.
- Time series files for selected discrete receptors – optional.

Note that these outputs should be provided for each of the 5 years of meteorological data, with compliance to be demonstrated for all 5 years.

10.   Approved version control

AERMOD has open access to the approved source code; however, there are a number of commercial software packages (with closed source code) that are marketed by third-party vendors. These software packages include:

- Proprietary GUI's designed to facilitate setting up the inputs for the model and/or analysing the model results, with often no changes to the AERMOD dispersion model kernel that is utilised by or embedded within the GUI.
- Proprietary software marketed as optimised versions of AERMOD that can provide the benefit of reduced runtimes from 'parallel'' processing utilising multiple processors.

The memorandum "Clarification on Regulatory Status of Proprietary Versions of AERMOD" (http://www.epa.gov/ttn/scram/guidance_clarificationmemos.htm) addresses the issues regarding the regulatory status of these proprietary software packages and includes the requirement to use test cases to demonstrate equivalency with the approved version.

EPA Victoria have procedures for approving, and/or demonstrating equivalency with the approved version of AERMOD, for any:

- Third-party software products (existing and future).
- Modified versions of AERMOD.

Approval from EPA Victoria is required if the use of alternatives to the currently approved version of AERMOD are proposed.

11.   Use of alternative models

Schedule C (Part A) of the SEPP (AQM) provides for the use of an alternative to the currently approved version of the regulatory model, whereby a proponent for a new or modified source of emissions to air can submit a modelling proposal to EPA Victoria seeking approval to use an alternative model, and demonstrating that the alternative model is appropriate for the circumstances.

Examples of cases where alternative modelling approaches may be required are as follows:

- Complex geographical locations whereby factors such as: terrain, coastal and land-use influences; in combination with the spatial scale of the impact zone of the sources; require the use of fully 3-dimensional meteorological fields. Potential alternative models for such circumstances include:

The CALPUFF modelling system (http://www.src.com/calpuff/calpuff1.htm).

The prognostic model TAPM (http://www.cmar.csiro.au/research/tapm/);

- Emissions from source types not modelled by AERMOD, eg. Aluminium refineries requiring the use of the buoyant line sources algorithms found in the CALPUFF model.