# Validation Report


# pDsAUSMOD-Australian GUI for AERMOD

This report was produced for EPA, Victoria and submitted to Principal Expert-Air Quality

By

**pDs Consultancy, Australia**

Validation was undertaken by

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Ex-EPA,Vic Senior Air Modeller

# Executive Summary

pDsAUSMOD is a Graphical User interface for the US EPA's AERMOD, which is now EPA, Victoria's regulatory air Dispersion model. This software package was developed in Australia, fulfilling air modelling requirements in Schedule C of the State Environment Protection Policy - Air Quality Management (SEPP(AQM)), as well as the specific requirements outlined in EPA, Victoria's publication #1551- Guidance Notes for using the regulatory air pollution model AERMOD in Victoria.

It has been validated following the validation process with 10 criteria, and this has been outlined in this document (Pages 5 and 6). This exercise comfortably verified that pDsAUSMOD satisfies all 10 criteria in the validation process. Five cases that cover/demonstrate all required performances were tested and results were documented.

pDsAUSMOD is recommended for use in running AERMOD (currently Version 12345) based on this vigorous validation process. pDs Consultancy, the developer of pDsAUSMOD assure its currency by upgrading its kernels and will also continually improve and enhance its functionalities.

# Validation of the Australian Graphical User Interface (GUI) for AERMOD : -pDsAUSMOD

## Introduction

This report is specifically produced to demonstrate that pDsAUSMOD functions properly and meets the requirements set in EPA, Victoria's guideline document "Guidance Notes for using the regulatory air model AERMOD in Victoria"

The AERMOD model software is structured with Path Ways. It has five basic pathways:

- CO – Control Pathway
- ME – Meteorological Pathway
- SO – Source Pathway
- RE – Receptor Pathway
- OU – Output Pathway

The graphical user interface in pDsAUSMOD basically has user input forms for each pathway. The additional sub forms are also built in to gather all the inputs required to run AERMOD. They are all linked appropriately. Novice user can navigate through the software following the logically set out sequential input prompts.

The pDsAUSMOD has been designed to have project folders on whichever device you install it on (Computer, Server or USB drive).
All required input files as well as output files will be written to this project folder. You can gather (load) all required input files from various locations and AUSMOD will automatically place them in a specified project folder. Here are the input and output files;

- Input files
  - Meteorological data files (.SFC,.PFL)
  - Receptor Elevation and Hill Height files (.REL)
  - Background Pollutant data files (.BGR)
  - Emission input files (.VRE) – Variable Emission

- Output files
  - AERMOD output (Generic name aermod.out as your model log file) file and error file
  - Top 100 Table (.RNK) as rank file
  - All required plot files with extensions (.PLT)
  - File with all the calculations (.POS)
  - BPIP input and output files

# Validation Process

1. Software Kernels

   pDsAUSMOD was built on the generic software components available from US EPA (http://www.epa.gov/scram001/dispersion_prefrec.htm). They are

   i. AERMOD V12345,
   ii. BPIP and
   iii. AERMAP.

| In the validation process it will be checked whether the right versions were embedded into pDsAUSMOD |
|---|

2. Check whether all basic pathways and sub-forms required for the main pathways are available in pDsAUSMOD.

   i. CO – Control Pathway
   ii. ME – Meteorological Pathway
   iii. SO – Source Pathway
   iv. RE – Receptor Pathway
   v. OU – Output Pathway

3. Check each pathway form to make sure all basic inputs and options required by EPA, Victoria (http://www.epa.vic.gov.au/our-work/publications/publication/2013/october/1551) are available.

   - Check whether provisions are available
     - To input constant and variable background
     - Emission and Concentration units including Odour
     - Averaging time
     - Terrain Flat or Ignore

   - Check whether provisions are available to incorporate basic type of sources: Point, Area and Volume

   - Check whether provisions are available
     - to incorporate Emission profiles.
     - to input variable emission files

- to input particle size distributions.

4. Check whether provisions are available for source grouping

5. Check whether provisions are available to design regular and irregular grids in Cartesian or Polar Coordinates
    - Does Google Mapping facility help to create grids in UTM ?
    - Check whether provisions are available to design Discrete Receptors in Cartesian or Polar Coordinates
    - Check whether provisions are available to design Flagpole Receptors.

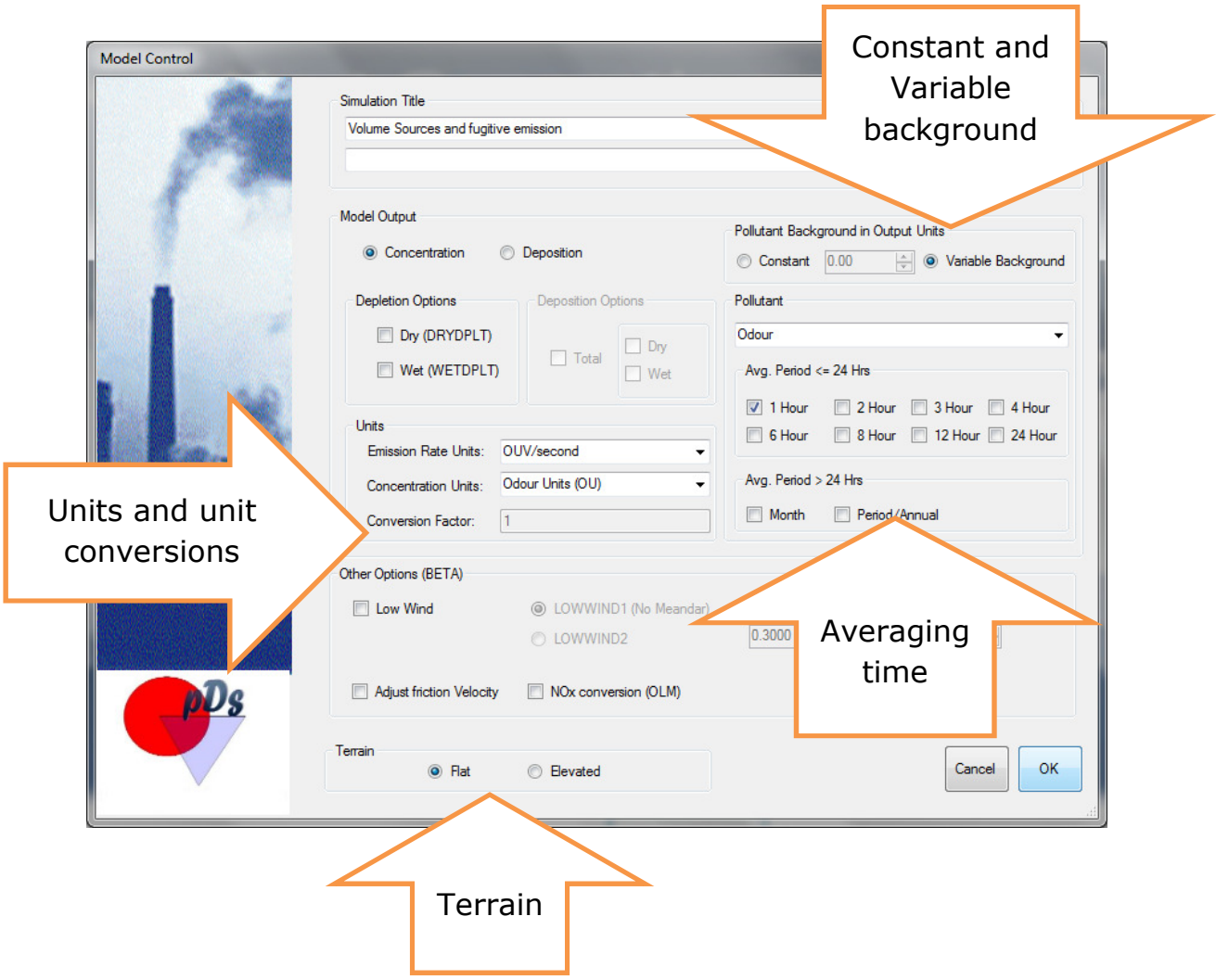
6. Check the interface for Building Information
    - Is user interface is appropriate to input all required information?
    - Is BPIP running without any Error?
    - Is BPIP output transferring to AERMOD input file?
    -
7. Check the interface for Terrain Processing
    - Are input file options appropriate?
    - Is google mapping functionality helpful?
    - Is AERMAP run without any error?
    - Is AERMAP output transferring to AERMOD input file?

8. Check weather all input information and options input by the user are transferred to AERMOD input file (.inp)

9. Check the AERMOD runs without any errors once all the required information is input.

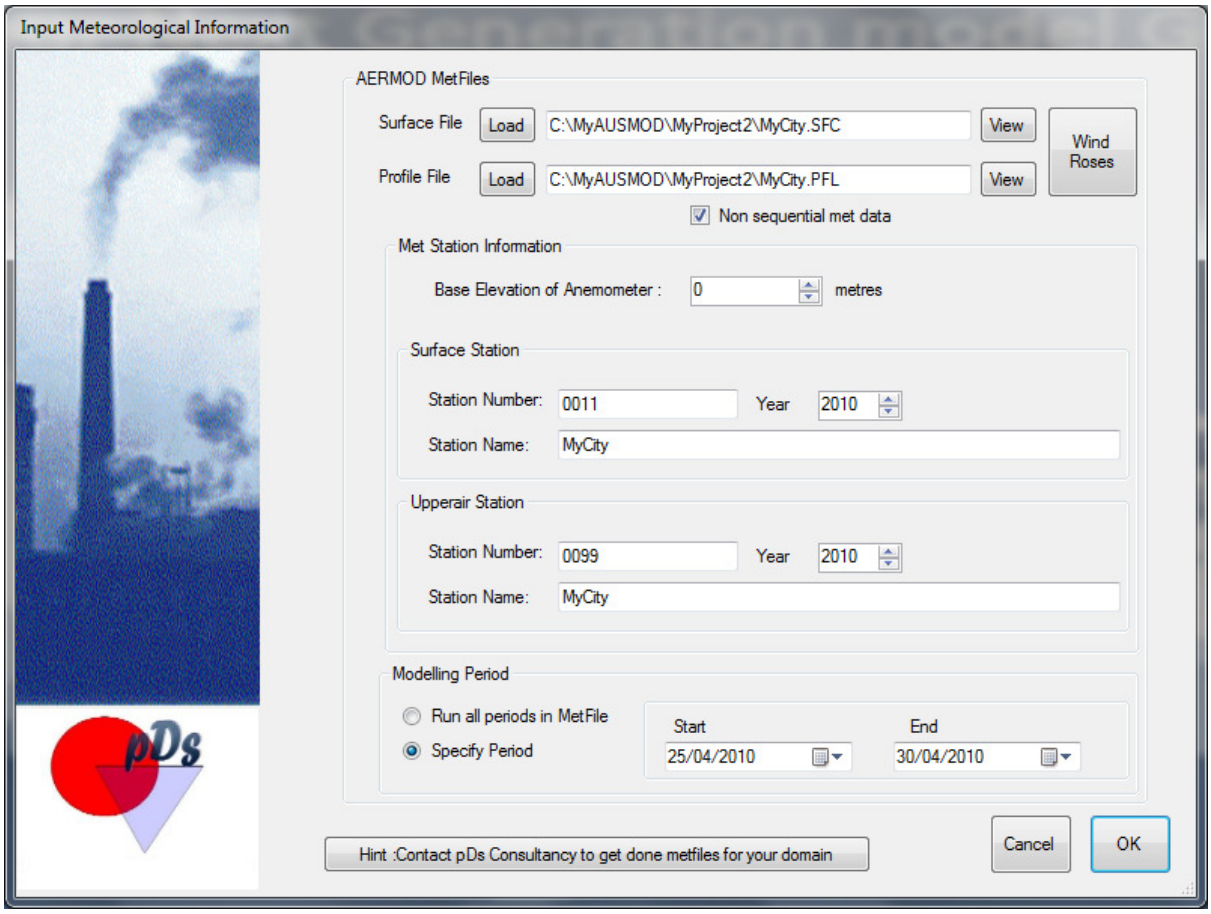
10. Are the internal graphics useful?
    - Is SURFER automation working properly?

# Form for Control Pathway (CO)




In addition, beta options like LOWWINDS, and Adjust friction velocity are available.
NOX conversion (OLM) is also incorporated.
Dry and Wet Depletion options are also in, though they are not in guidelines

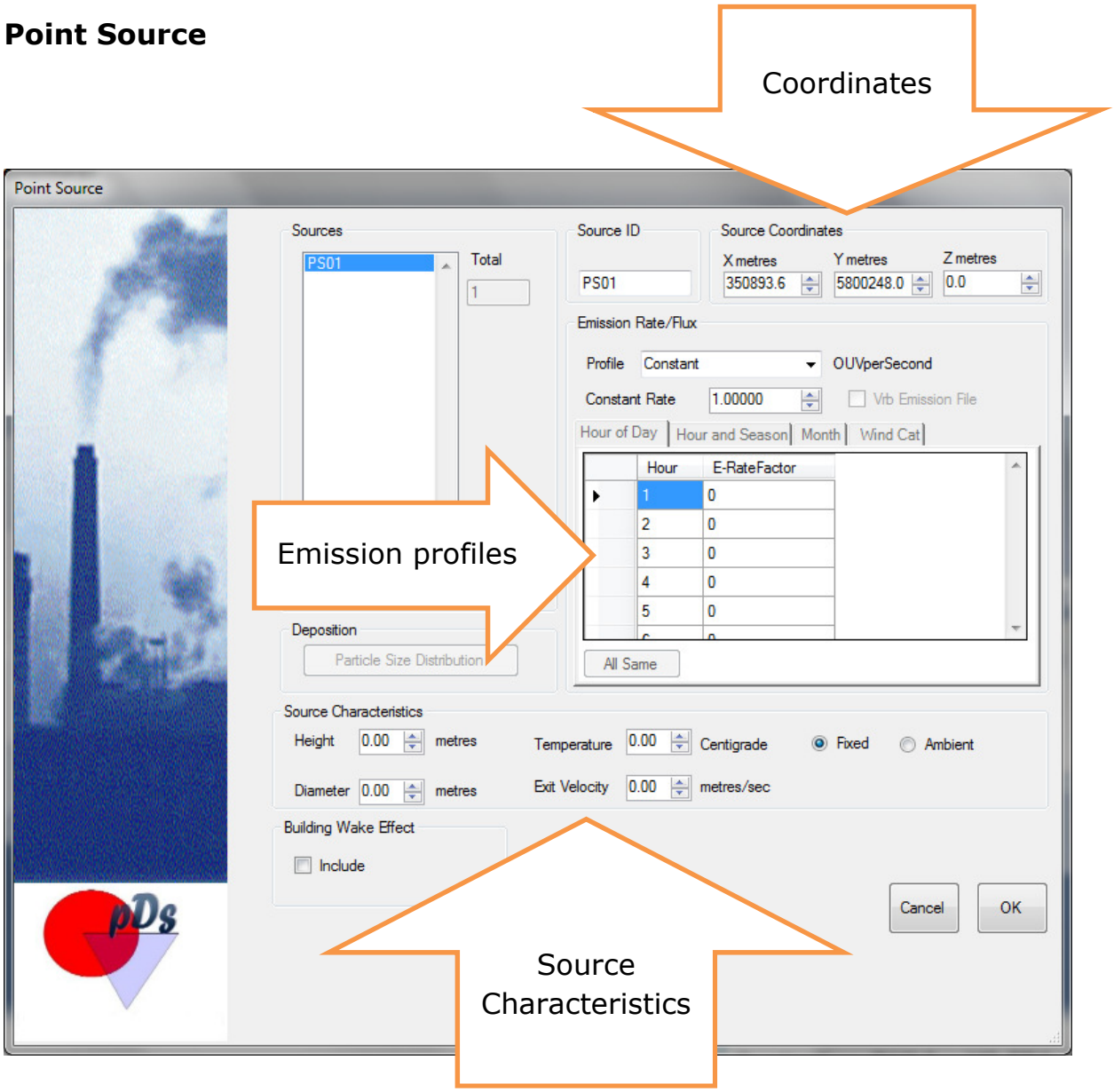
# Form for Meteorological Pathway




Provisions are given to input all required information including base elevation of anemometer. Non sequential met data option made default to satisfy local data coverage

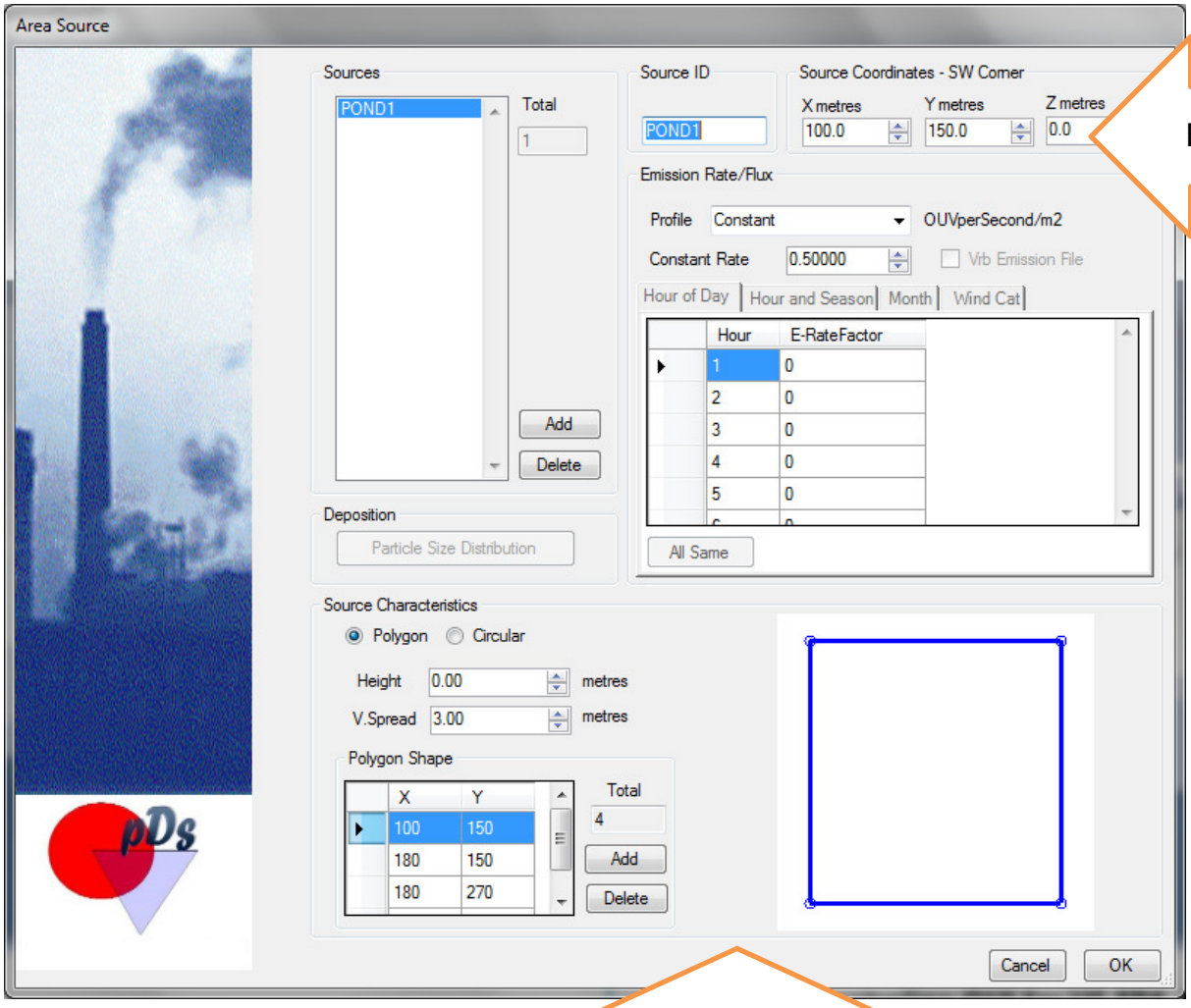
# Form for Source Pathway

**Point Source**




A button to call the Particle Size Distribution form is available

## Area Source

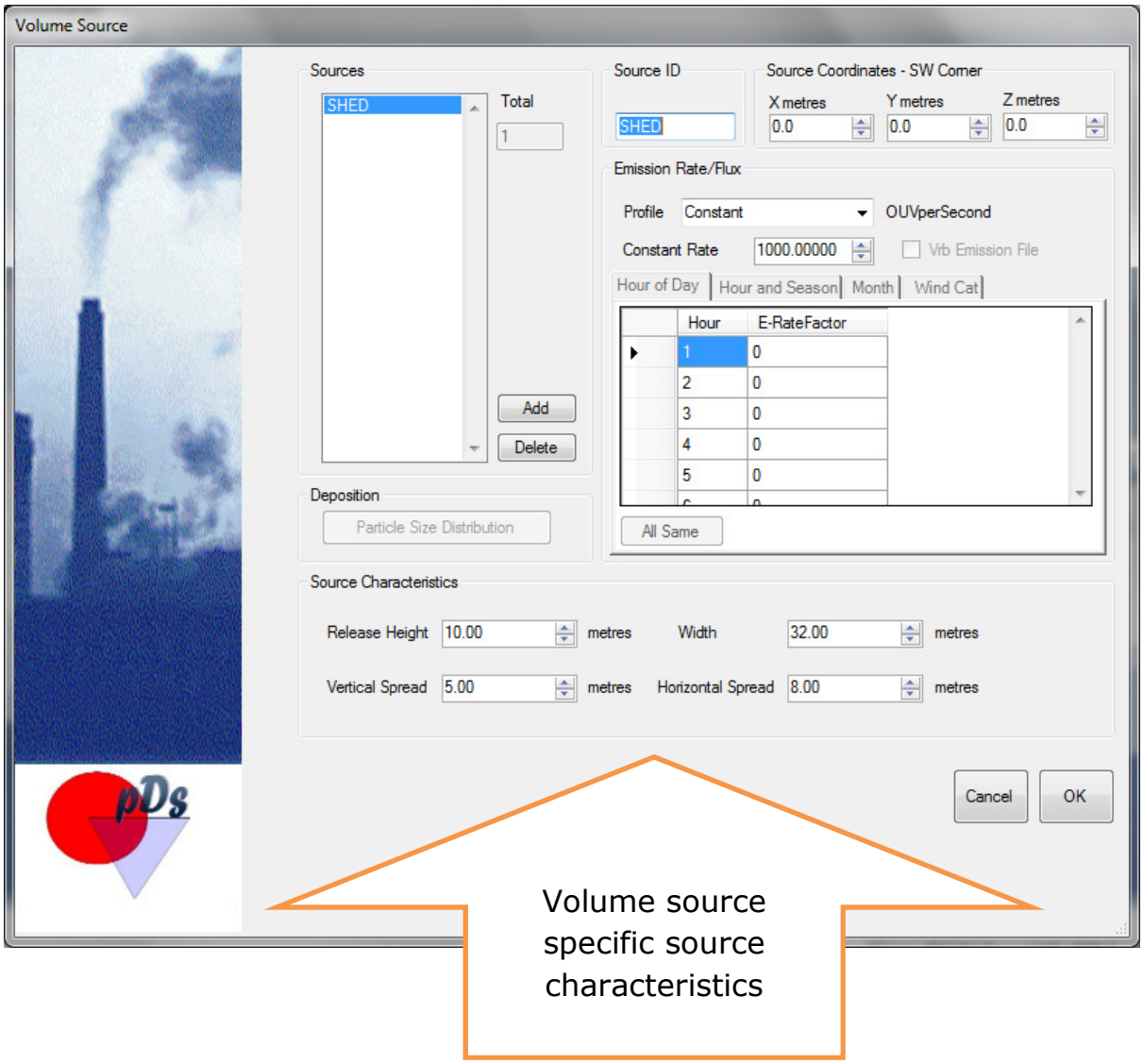



Flux

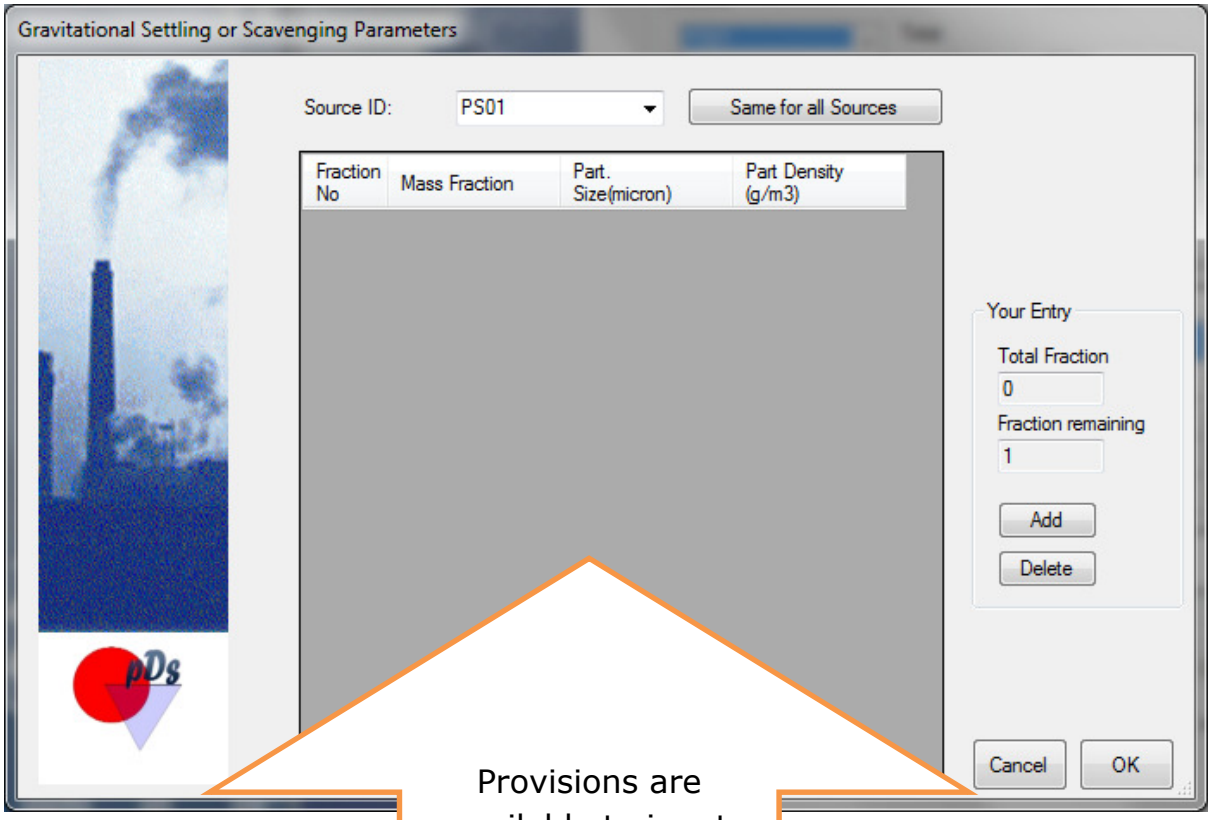
Shapes of Area Sources Polygon/Circular

Polygon covers; Squares, rectangles
Circular source is available.
Avoids coordinates mix up with real-time graphics

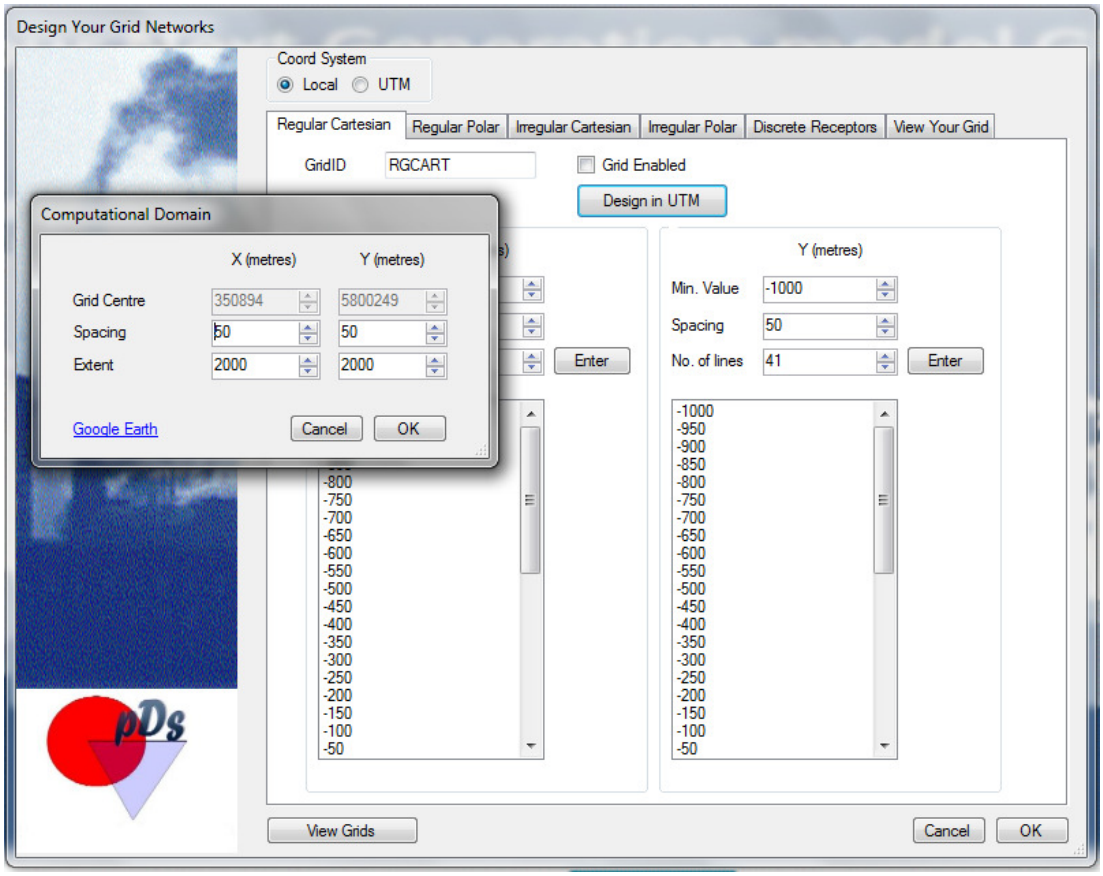
## Volume Source



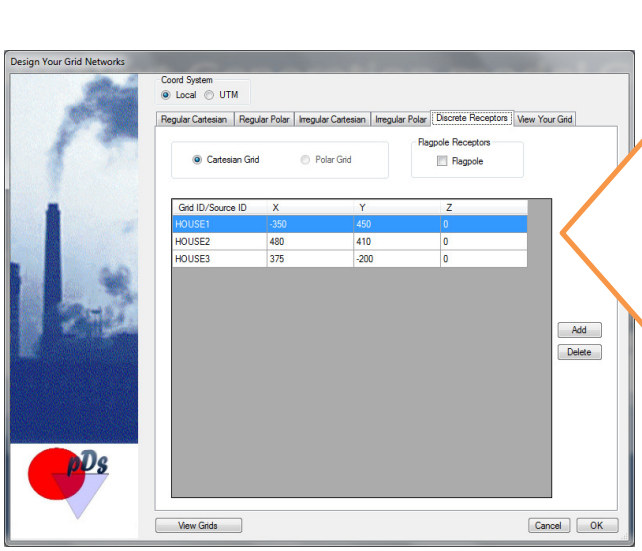
## Sub Form-Particle Size Distribution



# Form for Receptor Pathway

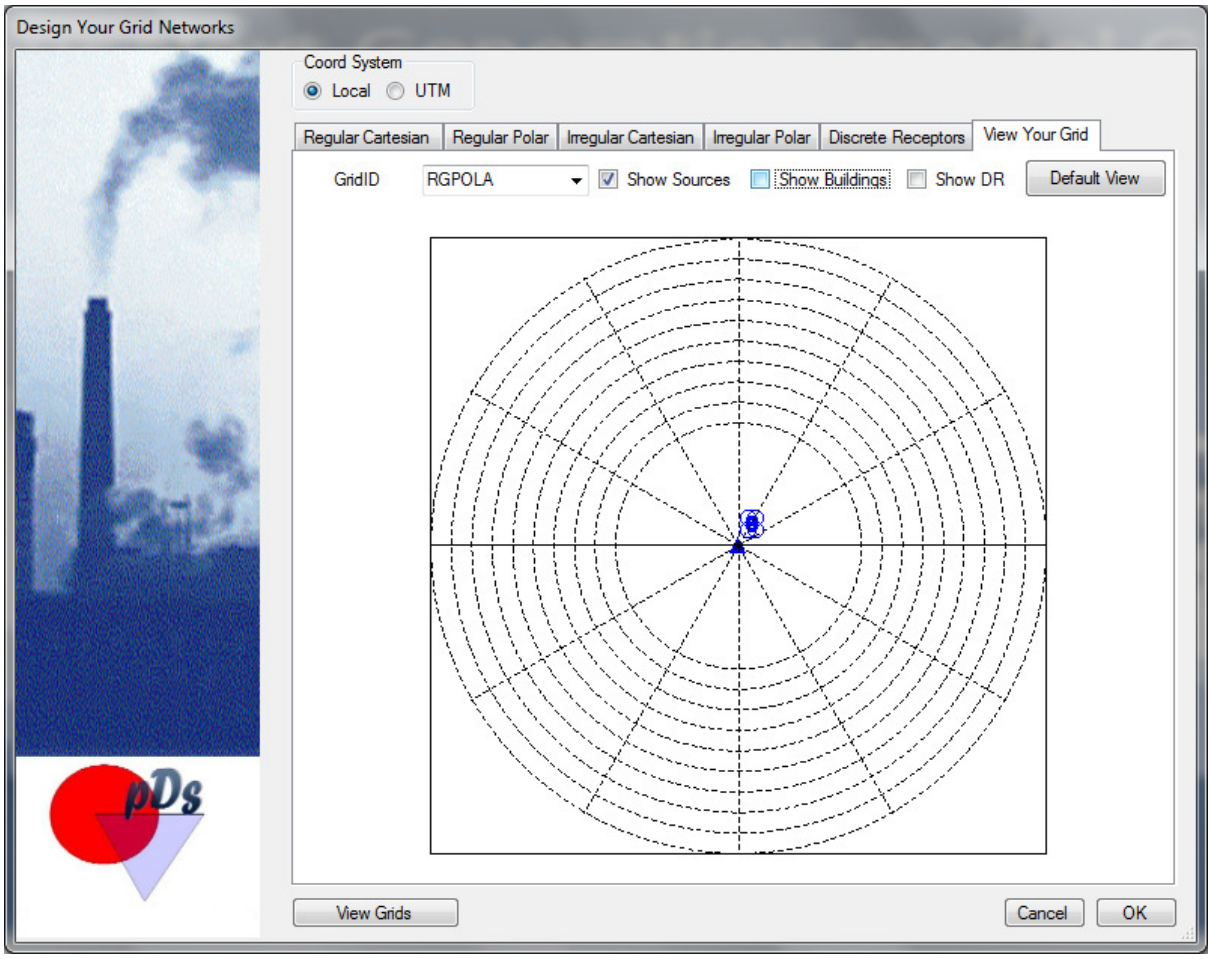



There are two types of Grids: Regular and Irregular in both Cartesian and Polar coordinate systems. The user can have their grid in the local or UTM coordinates system. These four grids and Discrete Receptor forms are available in Tab form. There is a separate Tab to view the designed grid(s).



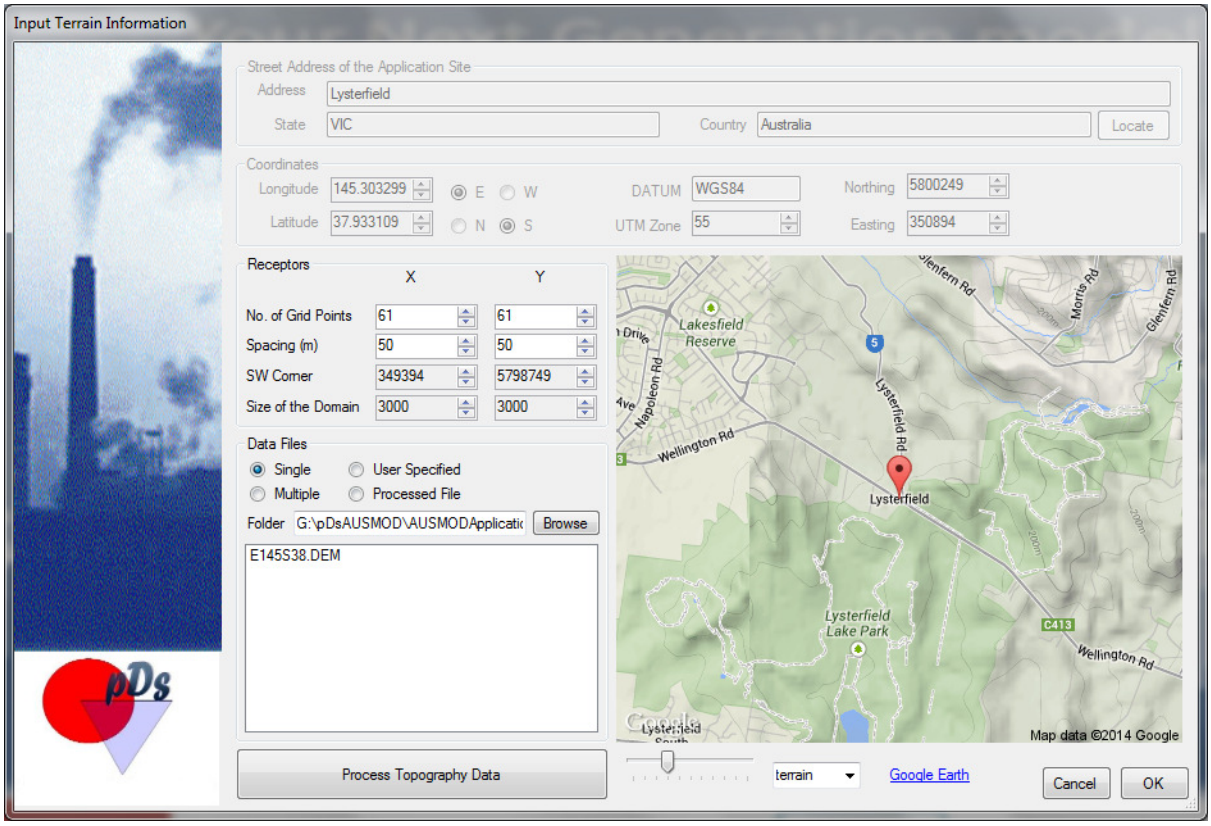

There is an option for Flagpole receptors

## Grid View




The user can overlay sources and buildings on the gird. This functionality helps users ensure that sources are inside the designed grid and are all in the same coordinates system.

# pDsAERMAP Interface



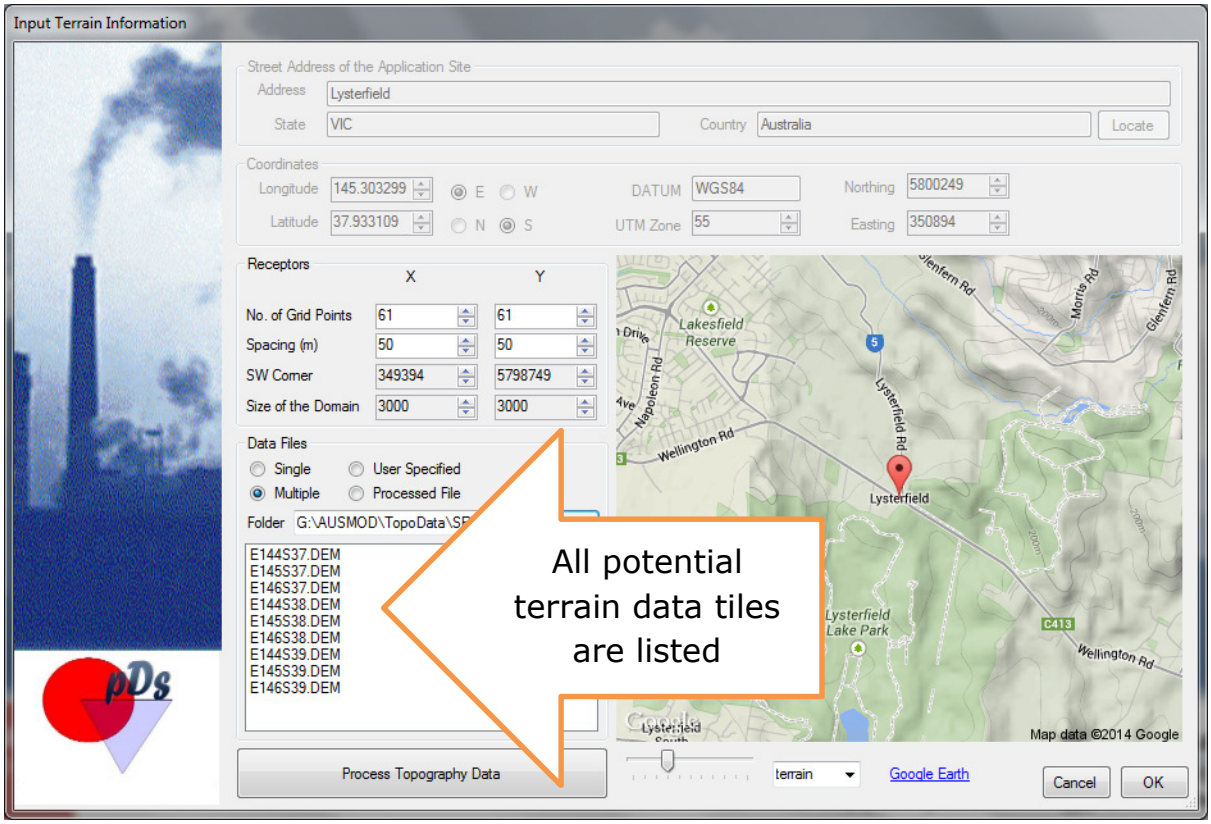

In this interface default grid size has been set to 3KM by 3KM. The grid centre is set to the UTM coordinates of the application site (internally linked to the MyDomain form which helps the user to determine geographical coordinates of the application site (Street address is required).

The interface is smart enough to show you the potential terrain data tiles required. These tiles should be in the US DEM format.

The user can change the grid resolution and the number of grid points. This helps the users to design the grid intheir desired size.

If the user intends to use the terrain data tiles in the US DEM format, the multiple file option is recommended. If the users are capable of obtaining terrain data for the specific domain the option "User Specified" is also available.

There is an option to load "Processed file-Receptor elevation and hill height file" for your convenience. This file can be prepared by running pDsAERMAP separately.

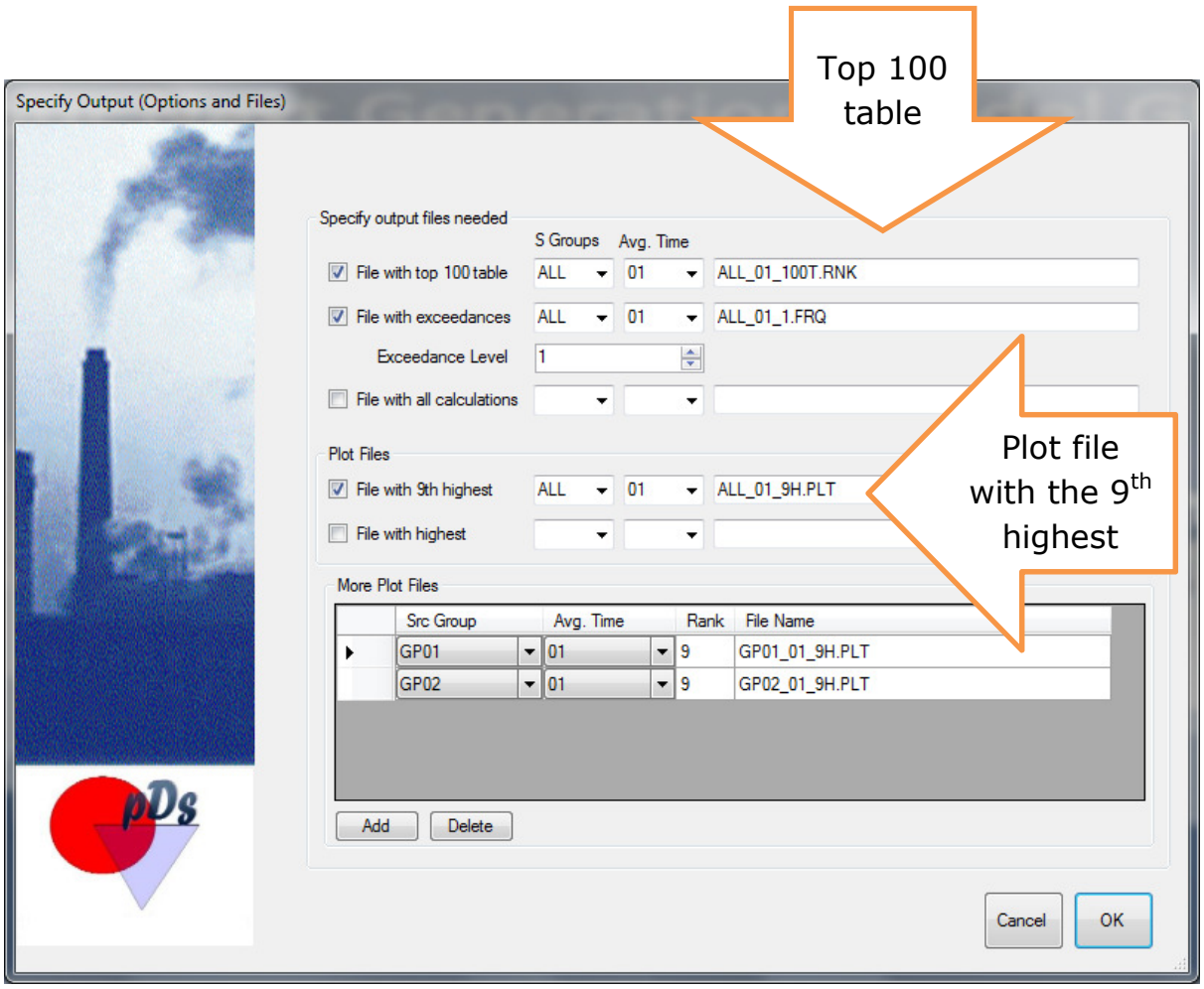



**Note:** Modern GIS systems can produce this type of data tiles if high resolution (at least 90m) terrain data is available.

You can run AERMAP to produce the receptor elevation file (.REL) once you have gathered all of the required terrain data tiles. You have to make sure all coordinates are in UTM in this particular project.

Additional features like the ability to view your domain in Google Earth, as well as construction topography contours are also available (as a QA/QC).

# Form for Output Pathway




Creation of frequently demanding files such as

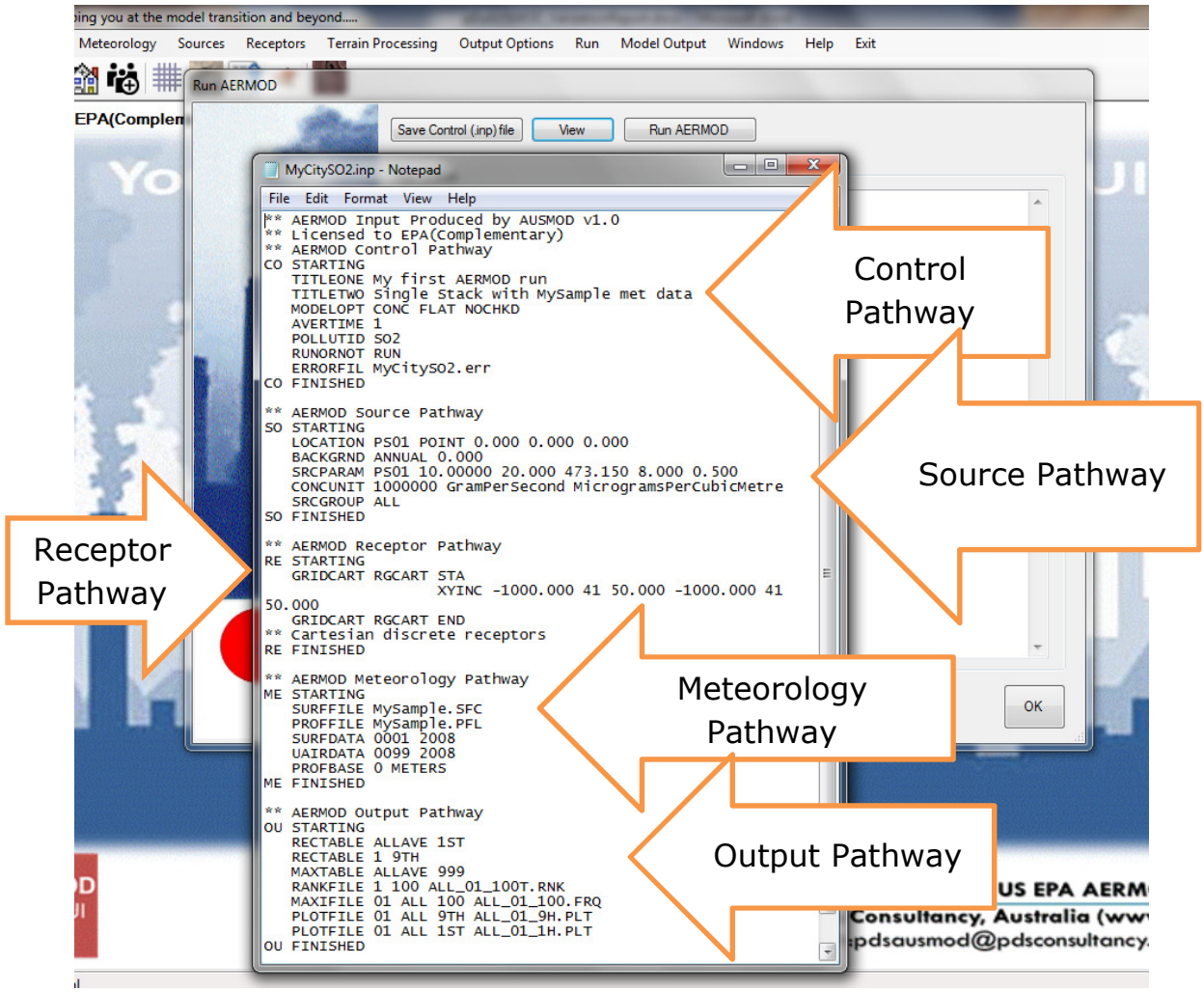
- The top 100 Table
- Plot file with 9th highest

These are made by default in pDsAUSMOD

The user can request other types of files; files can be written based on any combination of Grouping, averaging time and ranking.

# Running AERMOD

The following file demonstrates the successful creation of a generic input file for AERMOD by pDsAUSMOD.




**Test Case 1:**

Assume that you have a source located in MyCity. You have been provided with a full year of meteorological data (.SFC and .PFL), pre-prepared for MyCity, to model the residual emission coming out of this stack.

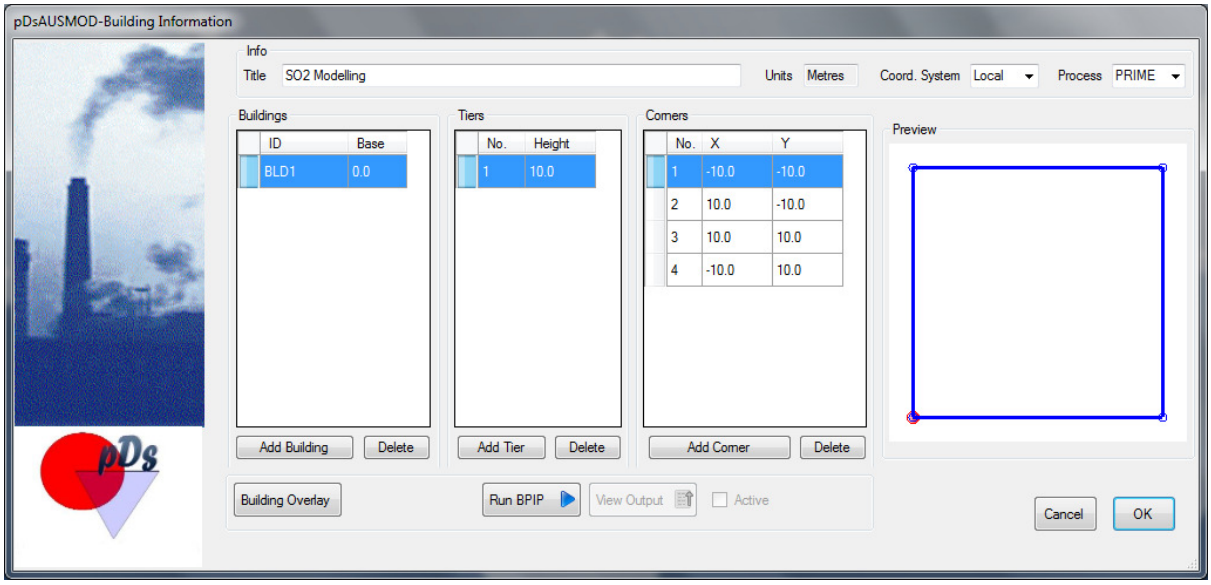
| | |
|---|---|
| **Source Height :20m** | **Diameter: 0.5m** |
| **Exit Temperature :200 C** | **Exit Velocity :8 m/s** |
| **Emission Rate :10 g/s** | **Background :0** |

Use the local coordinate system with the Grid Size 2KM by 2KM

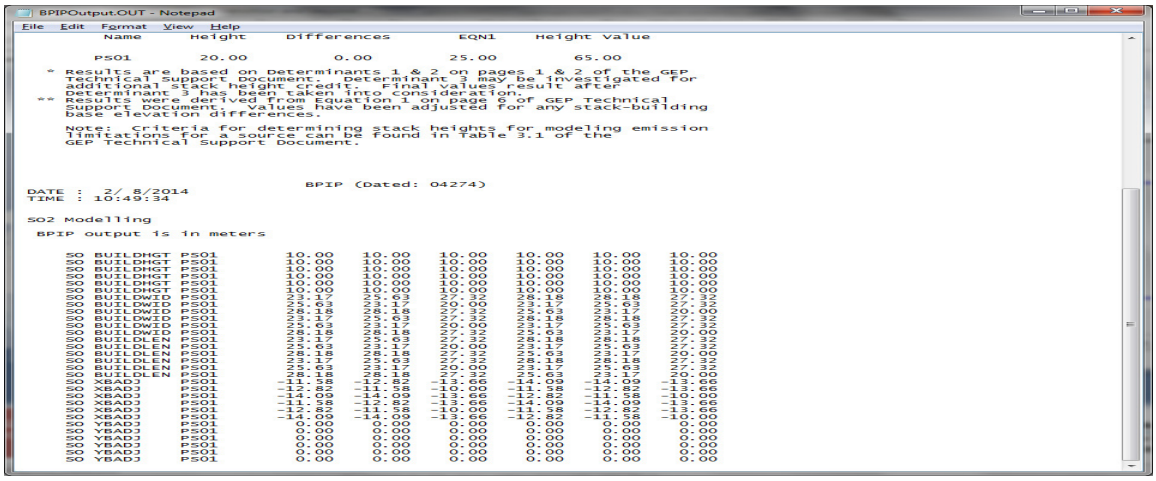
It is verified that all inputs and outputs were properly transferred to the AERMOD input by pDsAUSMOD.

**Test Case 2**: Add building wake effect to Case 1
Assume that the stack is on the centre top of the 10m by 10m square building.

## Input in the BPIP Interface

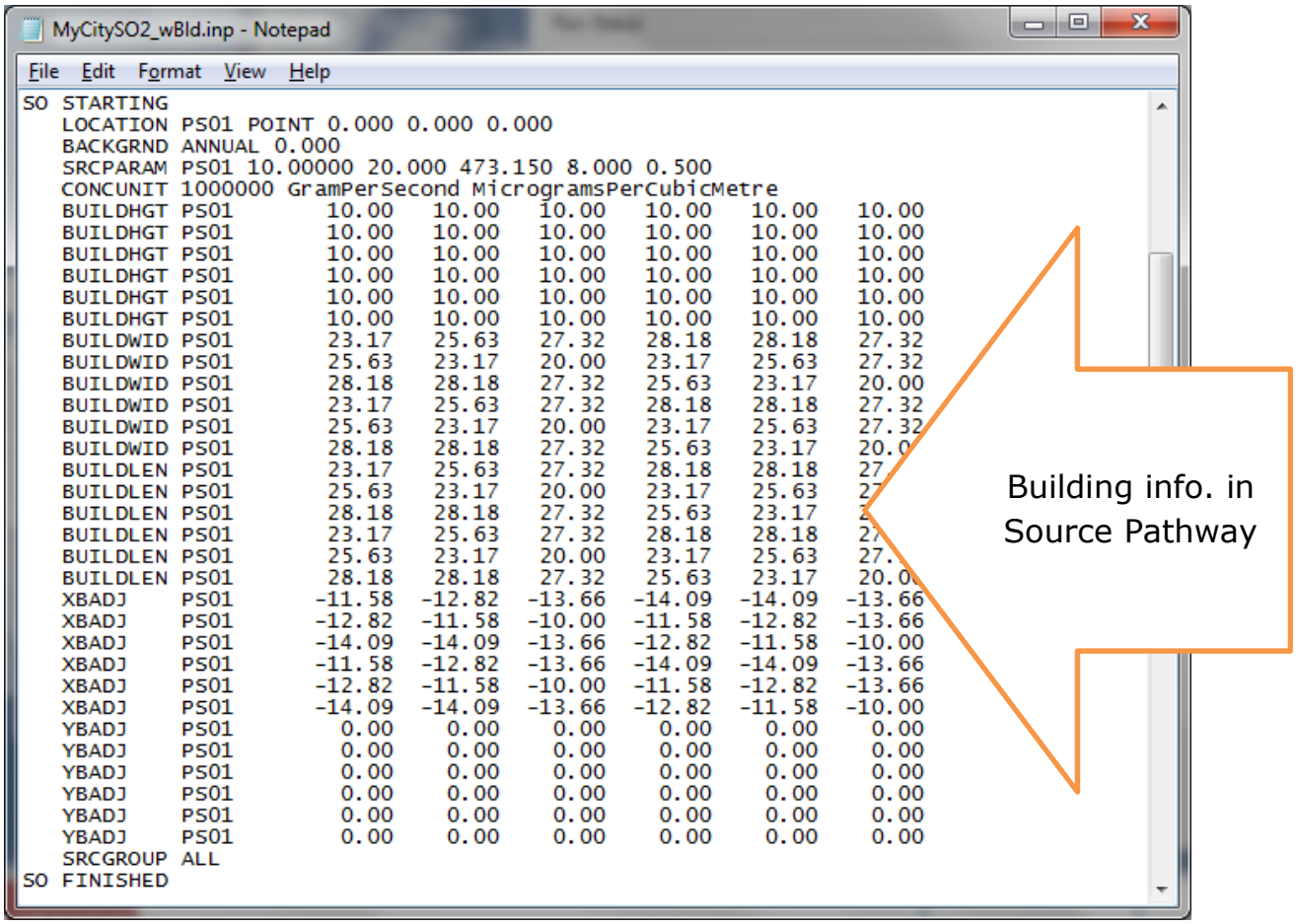



## BPIP run :Output




It is verified that BPIP interface in pDsAUSMOD worked properly running US EPA's generic BPIP producing correct output required for AERMOD.

## AERMOD input file for Test Case 2



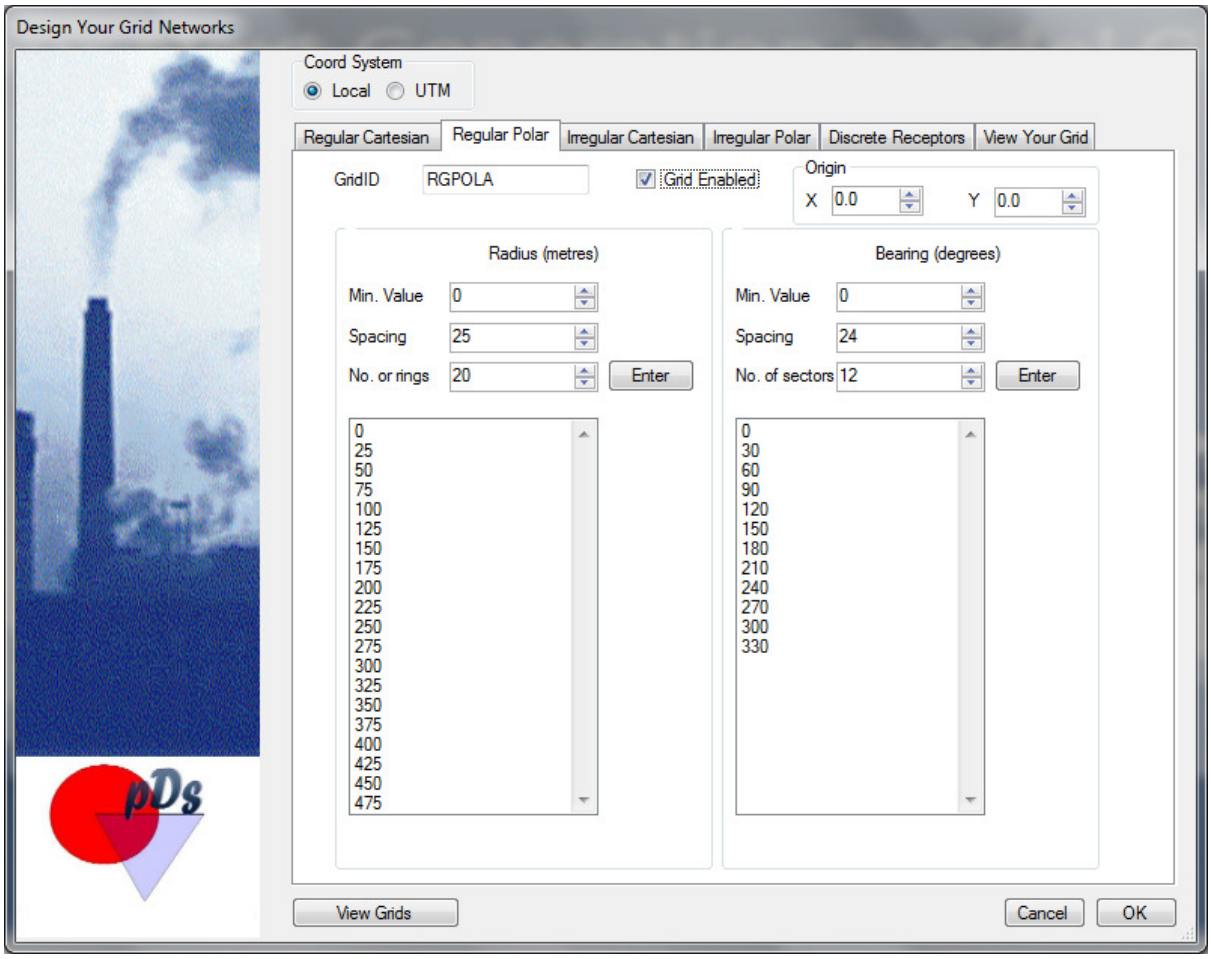

It is verified that the building info. was written to the AERMOD input file by pDsAUSMOD correctly.

**Test Case 3**: Fugitive Emission (Volume Source)

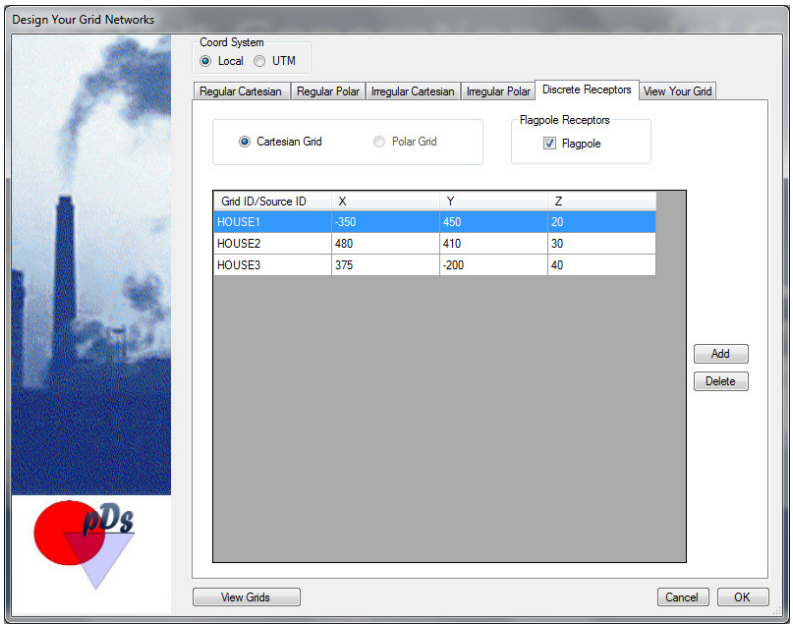
In this case the odours emitted from a building (20m high) in flat rural terrain is considered. The building is 32 m wide and 20 m high. Assume that the source is located in the centre of the site. The odour emission rate is estimated to be 1000 OUV/s. Here a Polar Grid and Discrete Flagpole receptors were used.

## Input in pDsAUSMOD

## Receptors in Polar



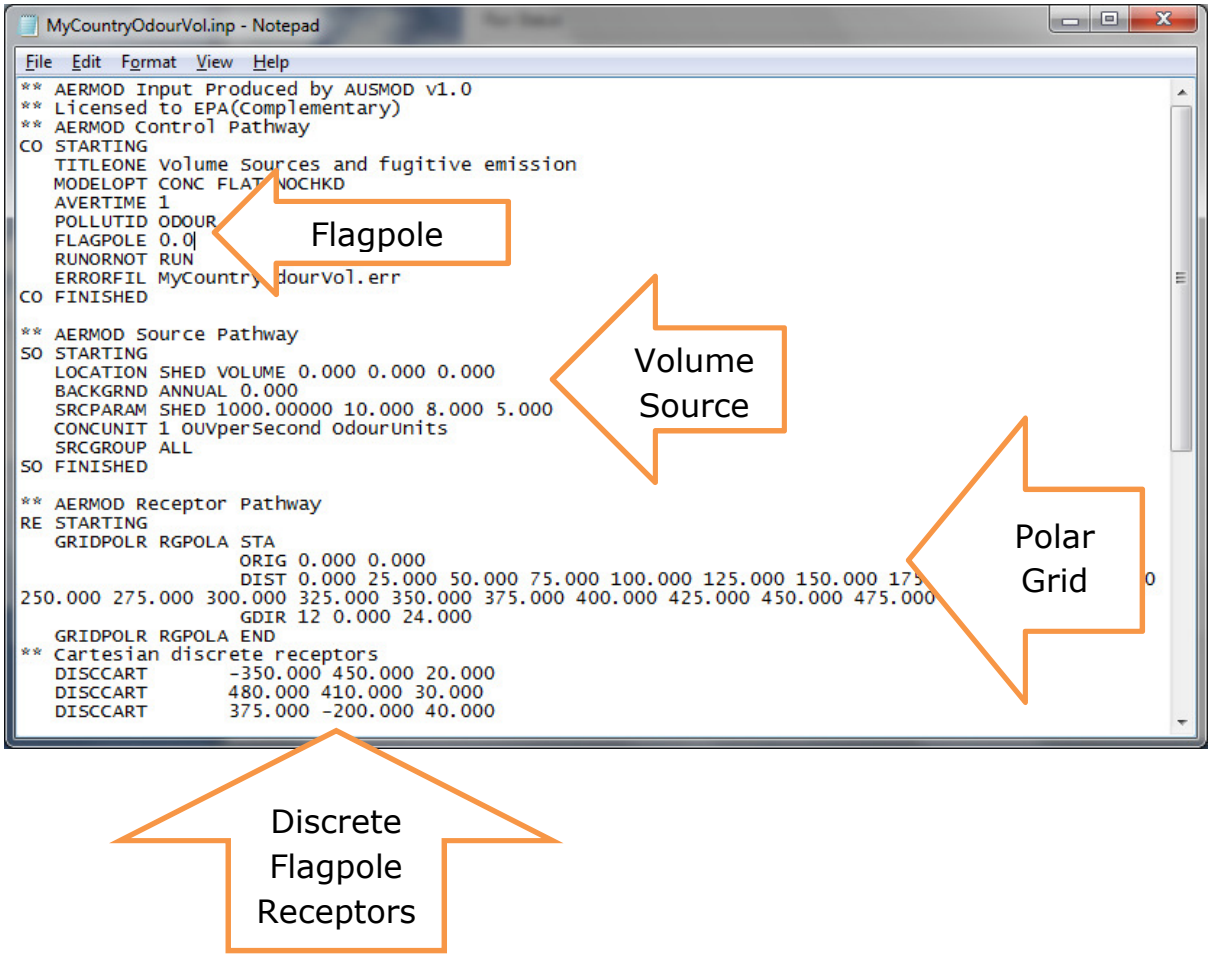

## Discrete Flagpole Receptors

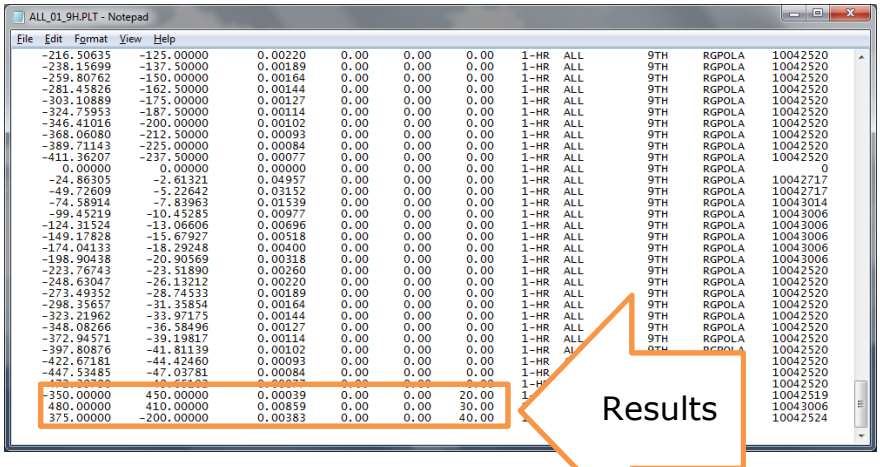


## AERMOD input file for Test Case 3

It is verified that the Volume Source info was transferred to the AERMOD input file corretly by pDsAUSMOD

In addition, Polar Grid and Discrete Flagpole Recptors were translated correctly by pDsAUSMOD



**AERMOD input file for Test Case 4: Area source and Source Grouping**

Emissions can also be emitted from diffuse area sources. Applications include odours from anaerobic lagoons, cattle feedlots or emissions from contaminated sites. We can model these sources as rectangles, circles or polygons.

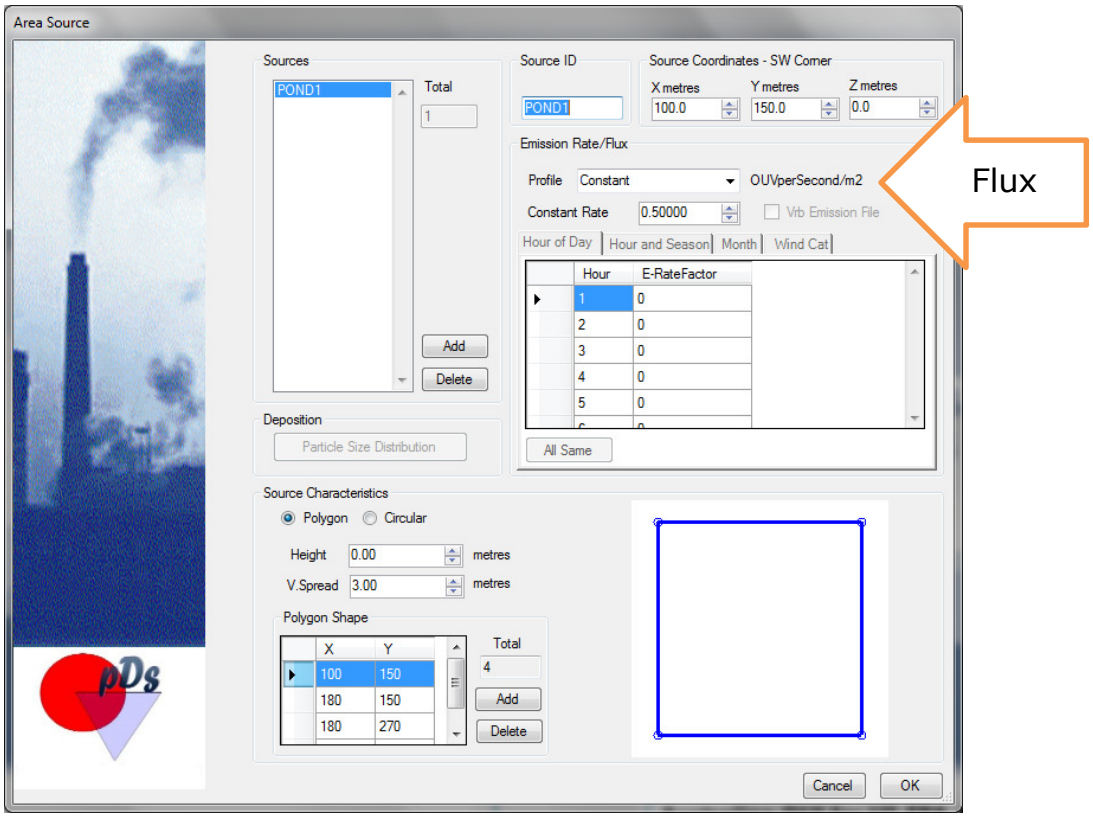
Assume odours are emitted from the following rectangular lagoon:

- Corner 1: South west corner  100, 150
- Corner 2: 180,150
- Corner 3: 180,270
- Corner 4: 100,270

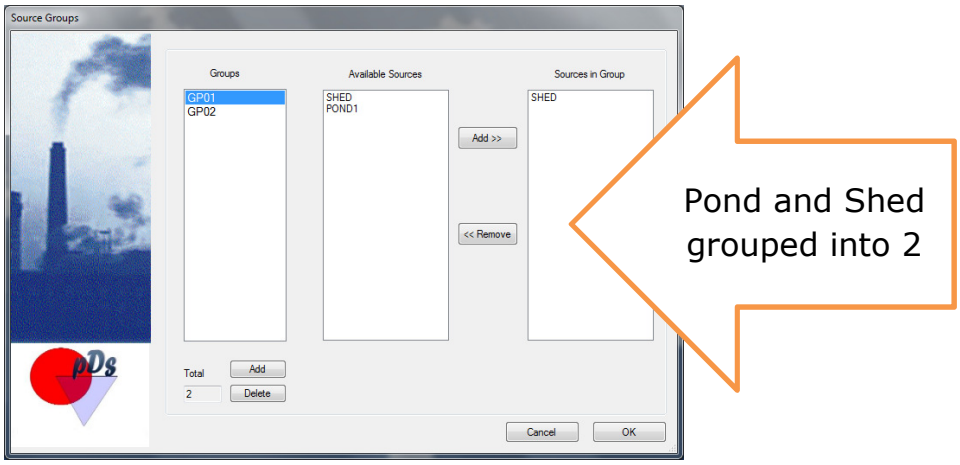
Source height: 0m

Emission flux 0.5 OUV/s/m² and vertical spread as 3. Add this souce to case 3 model setup

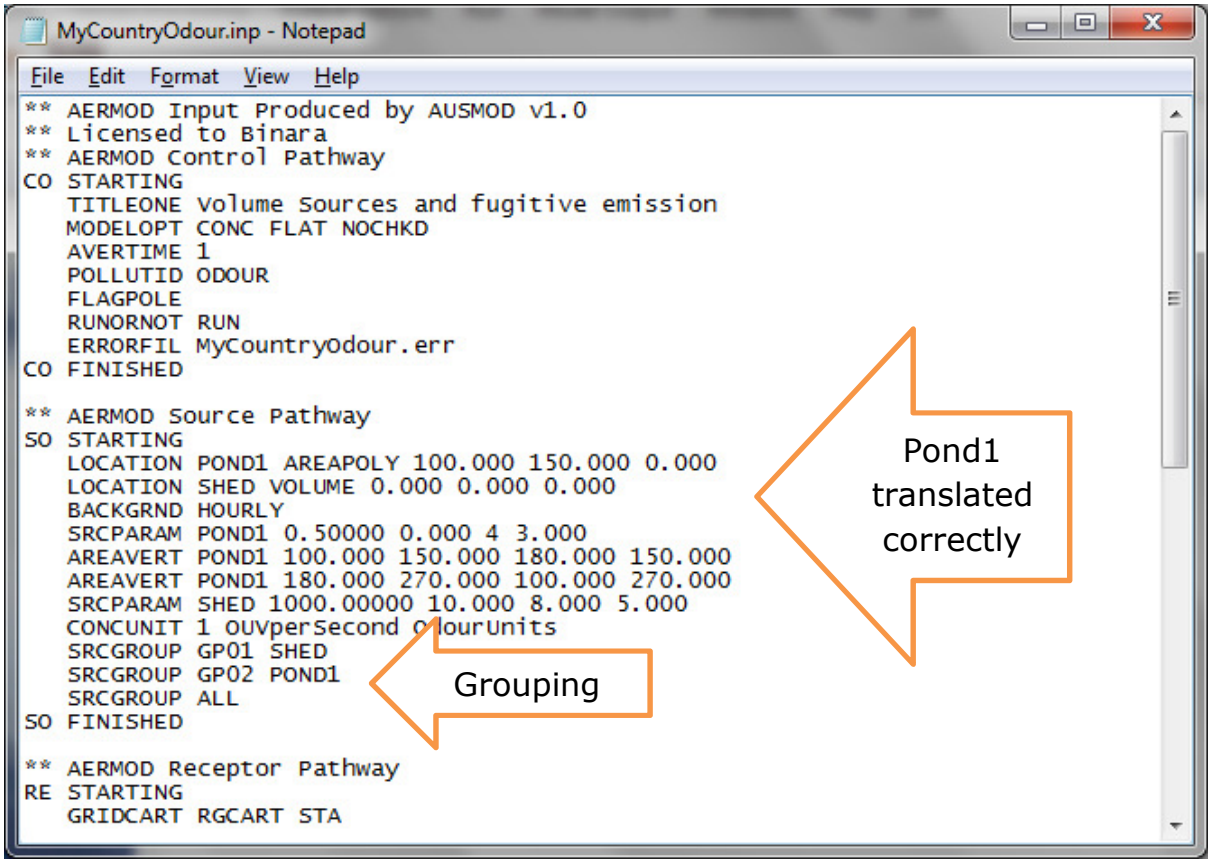
**Input in pDsAUSMOD**

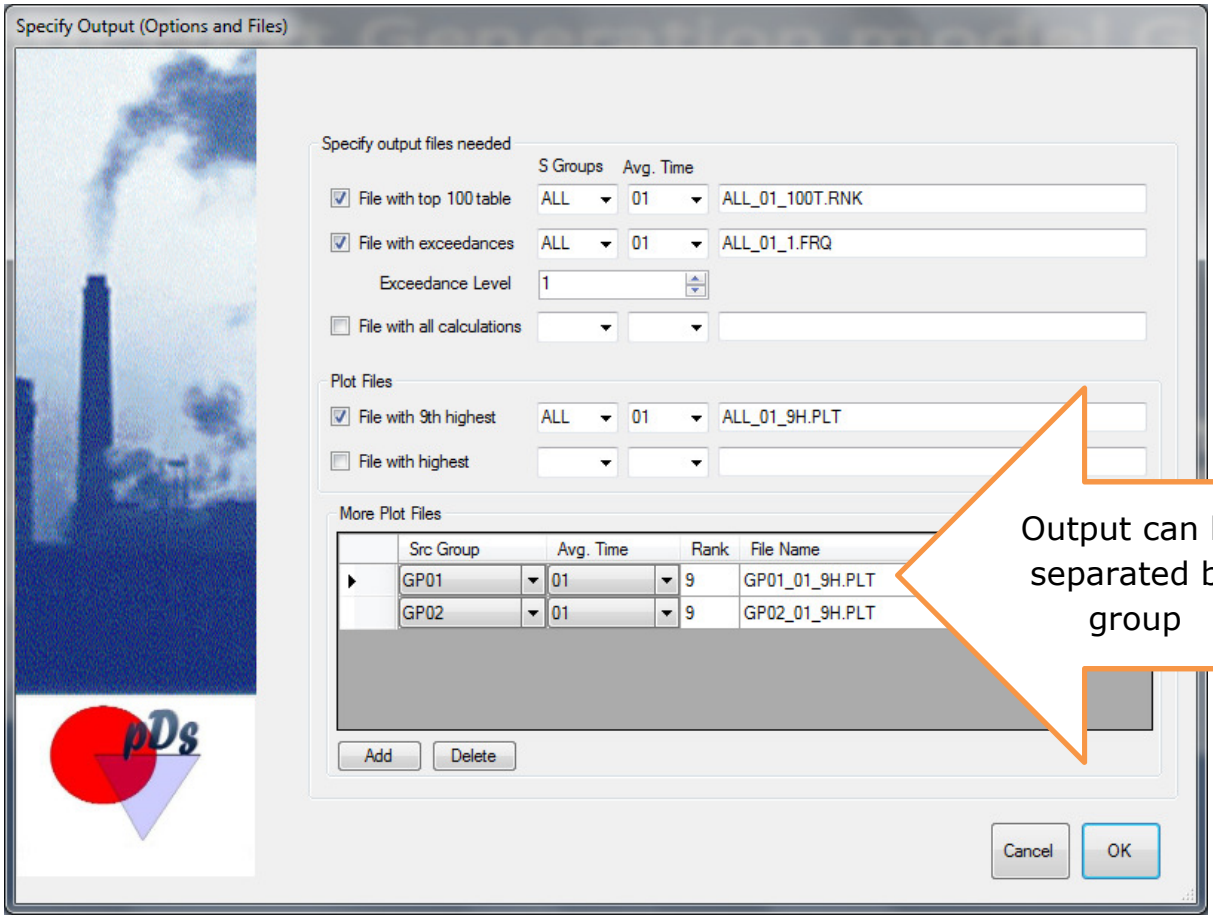


## Source Grouping




## AERMOD input file for Test Case 4

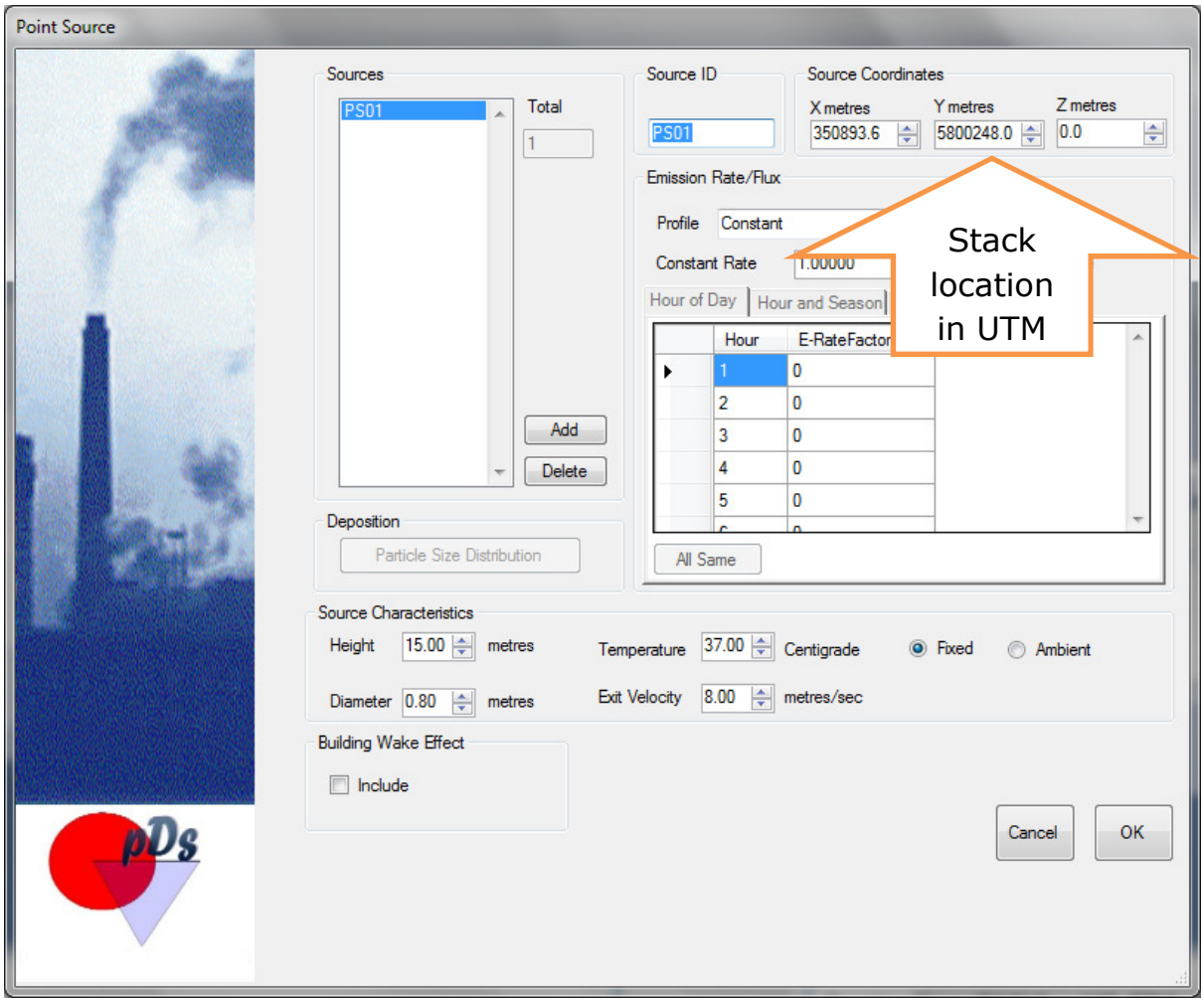




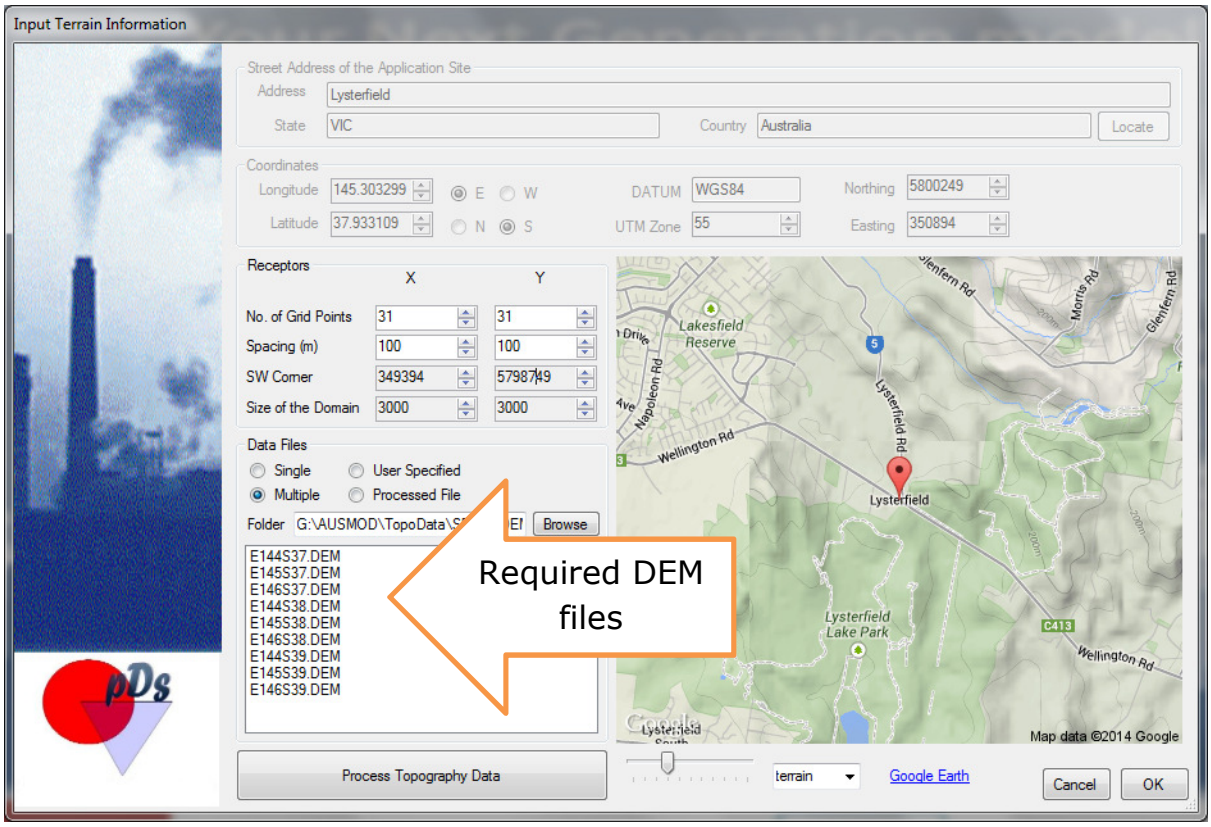

**It is verified that the Area Source information as well as source grouping were correctly translated into the AERMOD input file by pDsAUSMOD.**

## Test Case 5: Incorporation of terrain effect

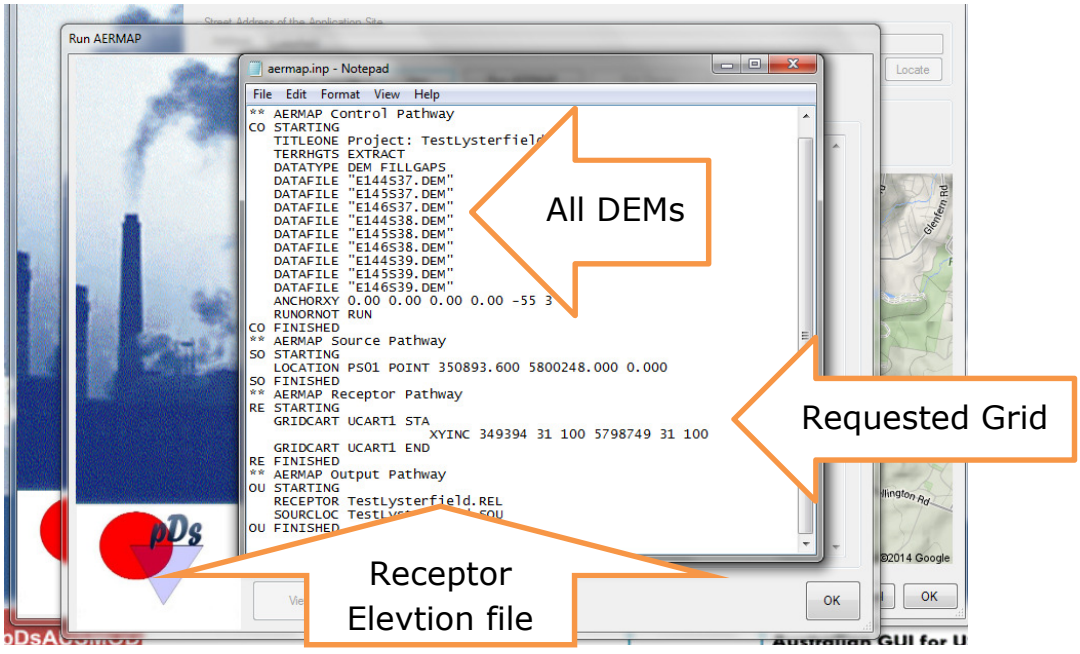
Assumed that there is a stack in Lysterfield Victoria. MyDomain in pDsAUSMOD helps to obtain the UTM coordinates for Lysterfield. These coordinates can be used as location coordinates of a stack there.

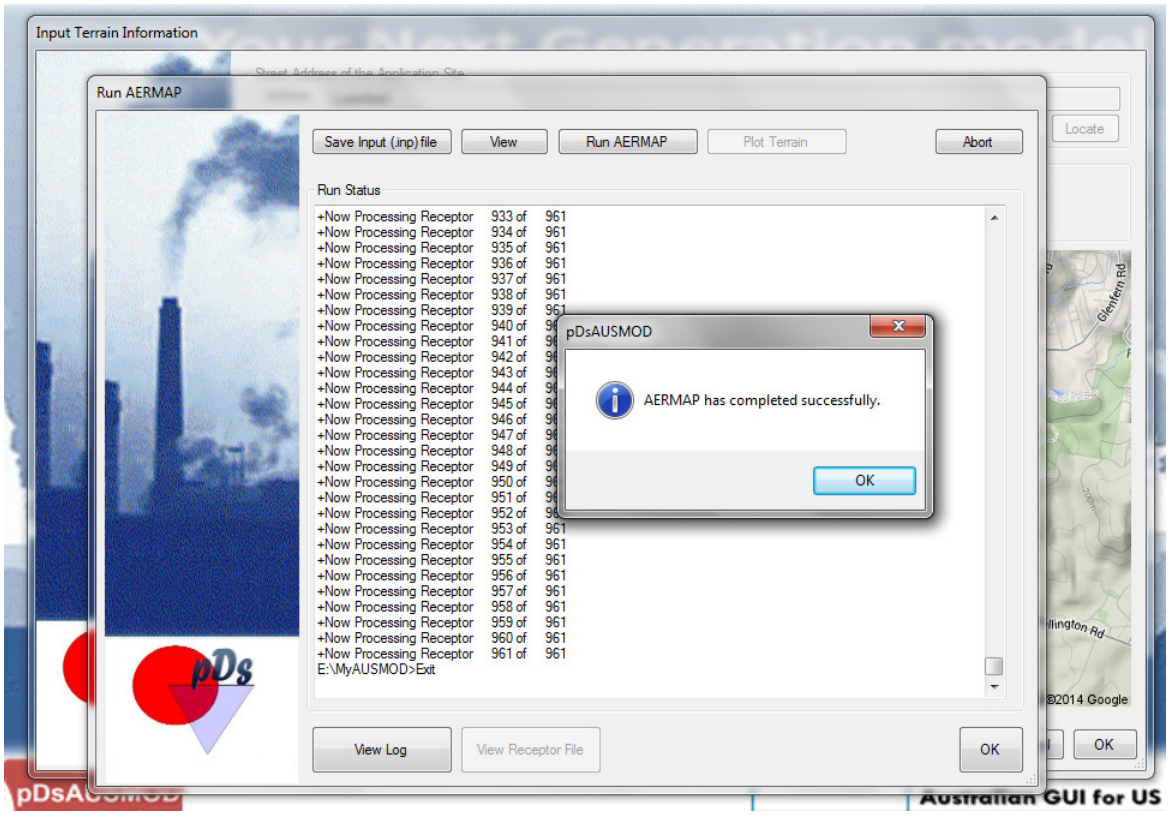


## AERMAP interface in pDsAUSMOD



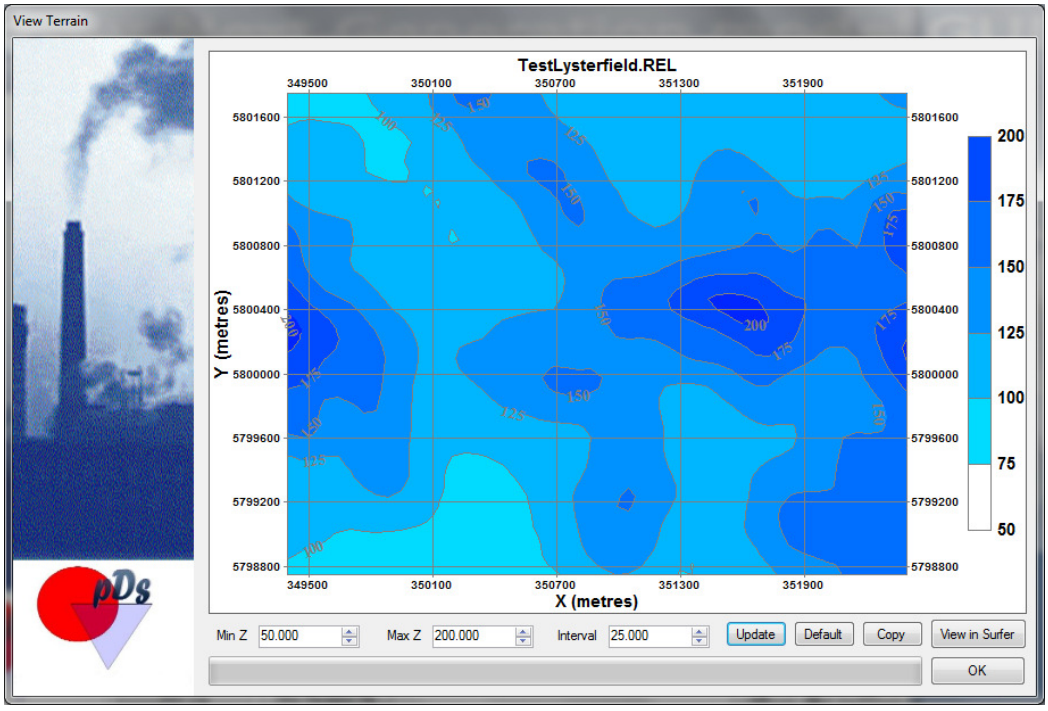

## AERMAP Run






This test verifies that the pDsAERMAP interface translates input info. properly and is capable of running generic AERMAP correctly.

Furthermore, this interface helps you to plot the terrain produced for your domain.



## Summary of Validation

1. pDsAUSMOD Kernels

| Program | Version | Verification | Comments |
|---|---|---|---|
| BPIP | V04274 | Available with pDsAUSMOD | Building Profile Input Program for PRIME (BPIPPRM) is the same as BPIP but includes an algorithm for calculating downwash values for input into the PRIME algorithm which is contained in such models as AERMOD. |
| AERMAP | V11103 | Available with pDsAUSMOD | Recommended latest version |
| AERMOD | V12345 | Available with pDsAUSMOD | AERMOD V13350 is the US EPA's latest. This upgrade do not affect to Victoria and V12345 is appropriate |

2. Forms and sub forms for Basic Pathways including all options are available with pDsAUSMOD –Verified.
3. Verified that all required inputs can be entered via the available forms.
4. Verified that the Source Grouping is available.
5. Verified that the Receptor Pathway is complete and working as desired. Supporting graphics and design are satisfactory.
6. The Interface for Building Information is appropriate to input required information for BPIP and the BPIP is running producing desired output to run AERMOD.
7. The Interface for AERMP is meeting local requirements and capable of running AERMAP by producing required receptor elevation and hill height file for AERMOD.
8. Verified that input information and options, input by the user are transferred to AERMOD input file (.inp).
9. Tested and verified that AERMOD is running without any errors.
10. Internal graphics and SURFER automation are satisfactory.

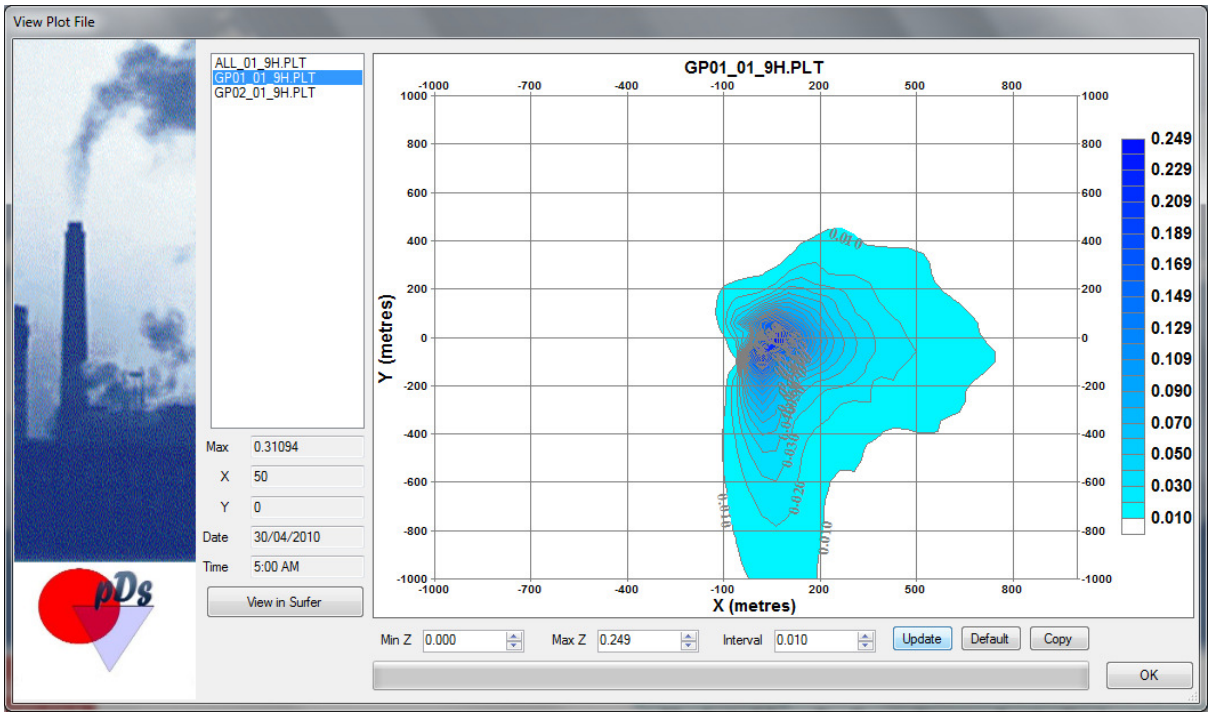
# Conclusion

The five test cases comfortably verified that pDsAUSMOD satisfies all 10 criteria in the validation process.

pDsAUSMOD is recommended for use in running AERMOD (currently Version 12345) based on this vigorous validation process. pDs Consultancy, the developer of pDsAUSMOD can assure its currency by upgrading its kernels and will also continually improve and enhance its functionalities.

# Appendix A

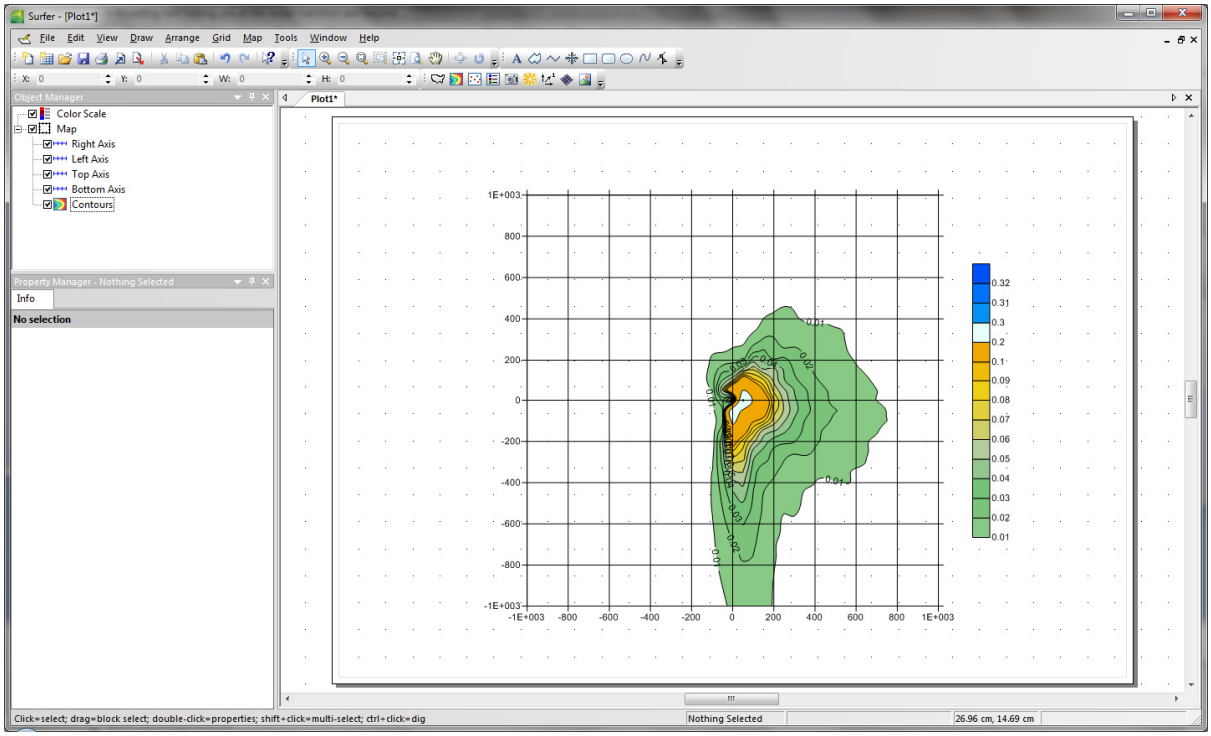
## pDsAUSMOD Internal Graphics




Internal graphics help to view the special distribution of predicted concentrations. You can view all output files (.plt) via this graphic package.

Importantly, Maximum predicted value, where it occurred when it occurred is also there.

The view in SURFER button helps you to view the unmodified output on SURFER (If SURFER V10 or above is available on your computer).



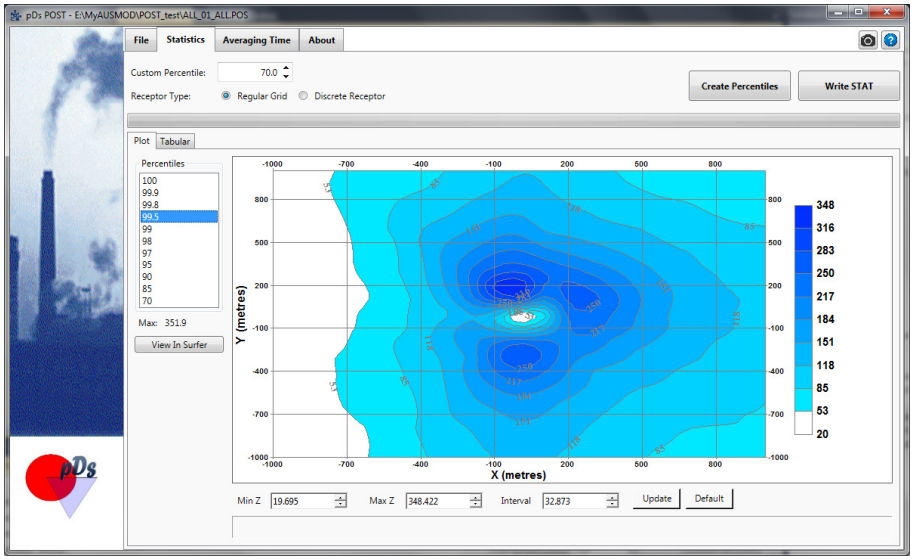

SURFER Automation is available in pDsAUSMOD.

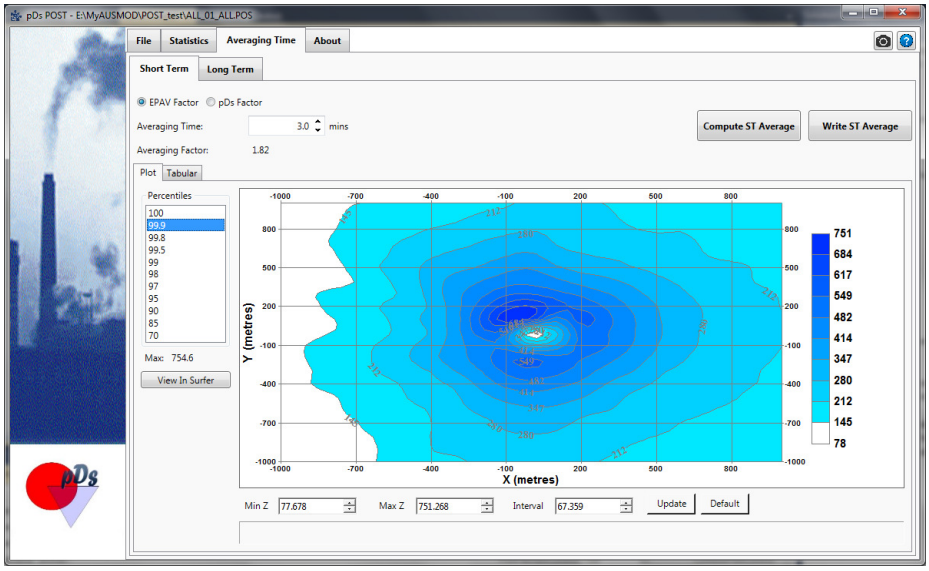
# Appendix B

**pDsPOST – Post processing AERMOD output**

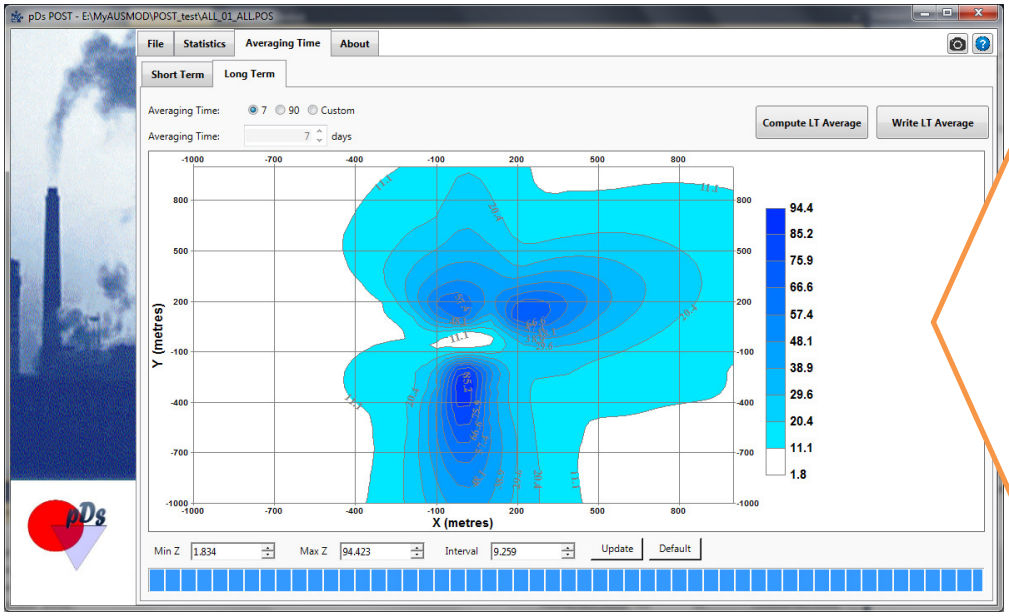
You can run AERMOD with an option to "Write all calculations". This option will produce a file (.POS) with all calculations. pDs has developed processing software which helps you post-process AERMOD output producing such output as

1. 3 minute/7 day/90 day averages
2. Standard Percentiles as well as user defined percentiles

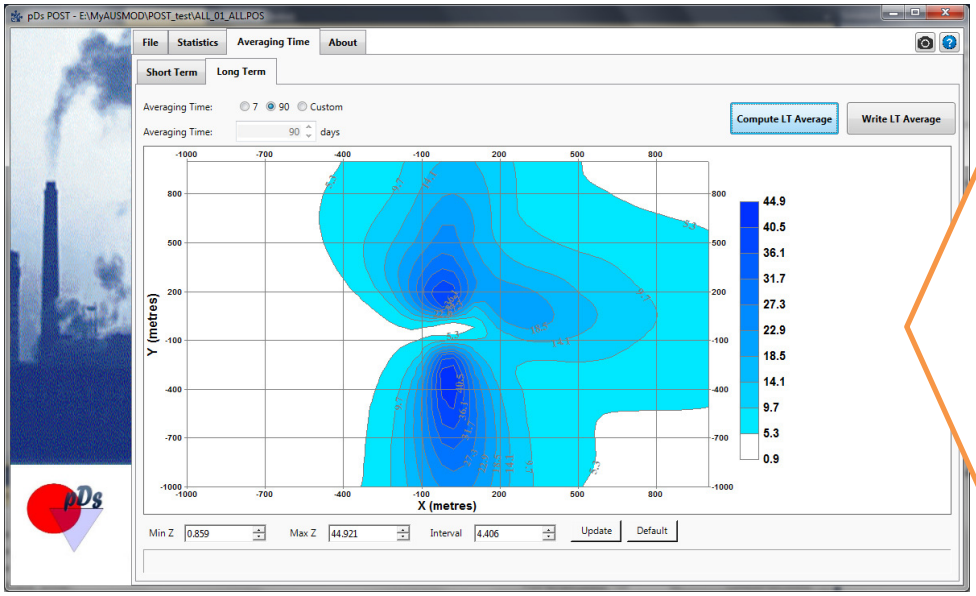



99.9 PC with 3min Avg




7 Day Average




90 Day Average

# Appendix C

## pDsWindRoses

The **pDsWindRoses** software basically depicts the frequency of occurrence of winds in each of the 16 direction sectors (every 22.5 degrees) and 6 wind speed classes for a given location and time period specified by the user.

This package accepts all files in specific formats such as

1. AERMOD (.sfc)
2. AUSPLUME (.met)
3. TAPM (.csv)
4. CALMET (.dat)
5. Raw data prepared in .csv format