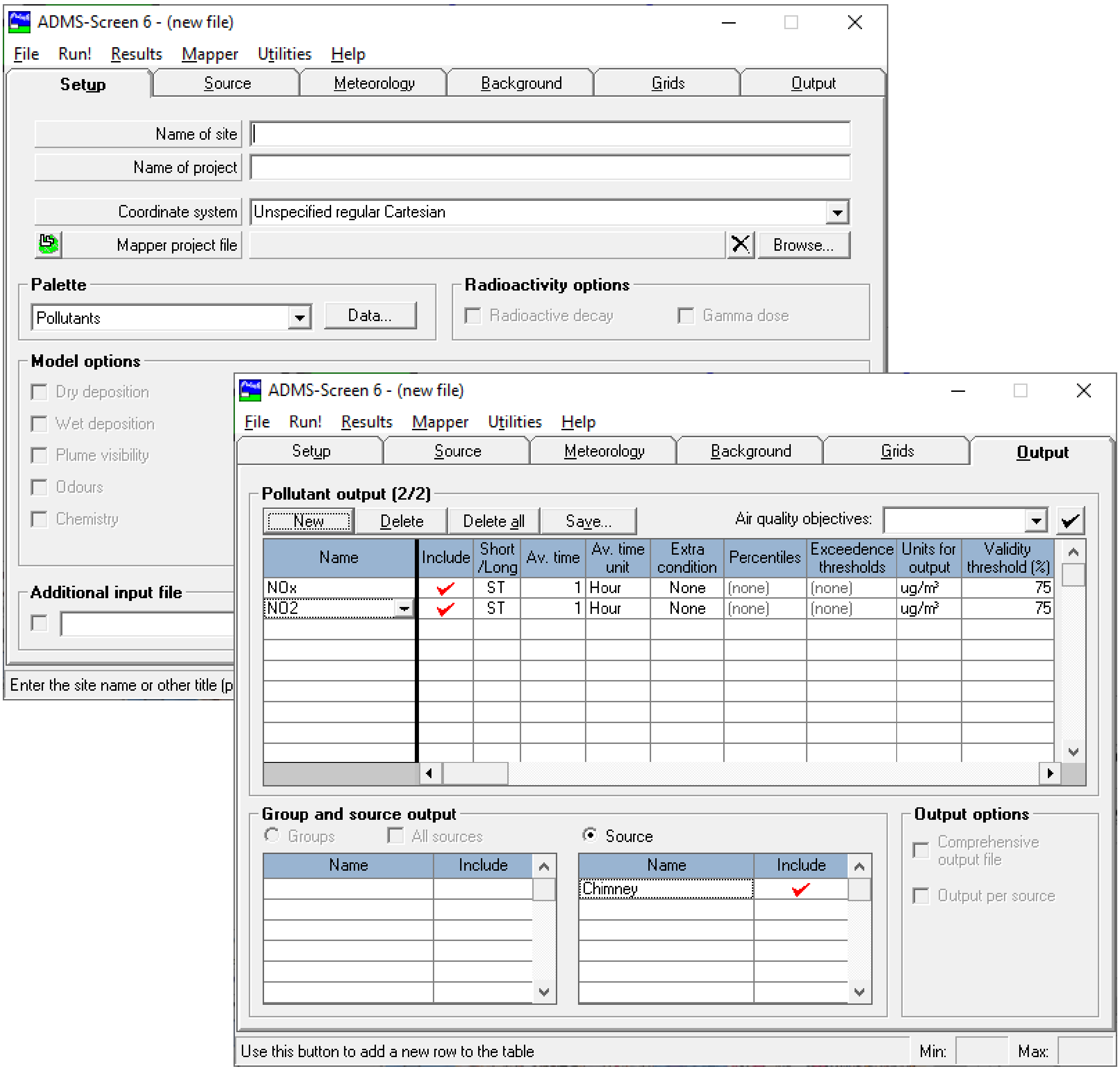
ADMS-Screen

Atmospheric Dispersion Modelling System Screening Tool



User Guide CERC

ADMS-Screen

Atmospheric Dispersion Modelling System Screening Tool

User Guide

Version 6.0

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SECTION 1 Introduction

1.1 About ADMS-Screen

What is ADMS-Screen?

ADMS-Screen is a practical, short-range dispersion model that simulates a wide range of buoyant and passive releases to the atmosphere. It is a "new generation" dispersion model in the sense that it uses two parameters to describe the atmospheric boundary layer, namely the boundary layer height *h* and the Monin-Obukhov length L_{MO}, and a skewed Gaussian concentration distribution to calculate dispersion under convective conditions. The model is applicable up to about 60 km downwind of the source and provides useful information for distances up to 100 km.

ADMS-Screen is supplied with a Mapper that can be used to visualise, add and edit sources, buildings and output points and to view model output. It also links to other software packages, such as Surfer, a contour plotting package for easy and effective display of results, and ArcGIS and MapInfo GIS (Geographical Information System) software, for display of results and easy data entry. Separate User Guides are provided for using the Mapper and links to ArcGIS and MapInfo. More information about using Surfer with ADMS-Screen is provided in Appendix D.

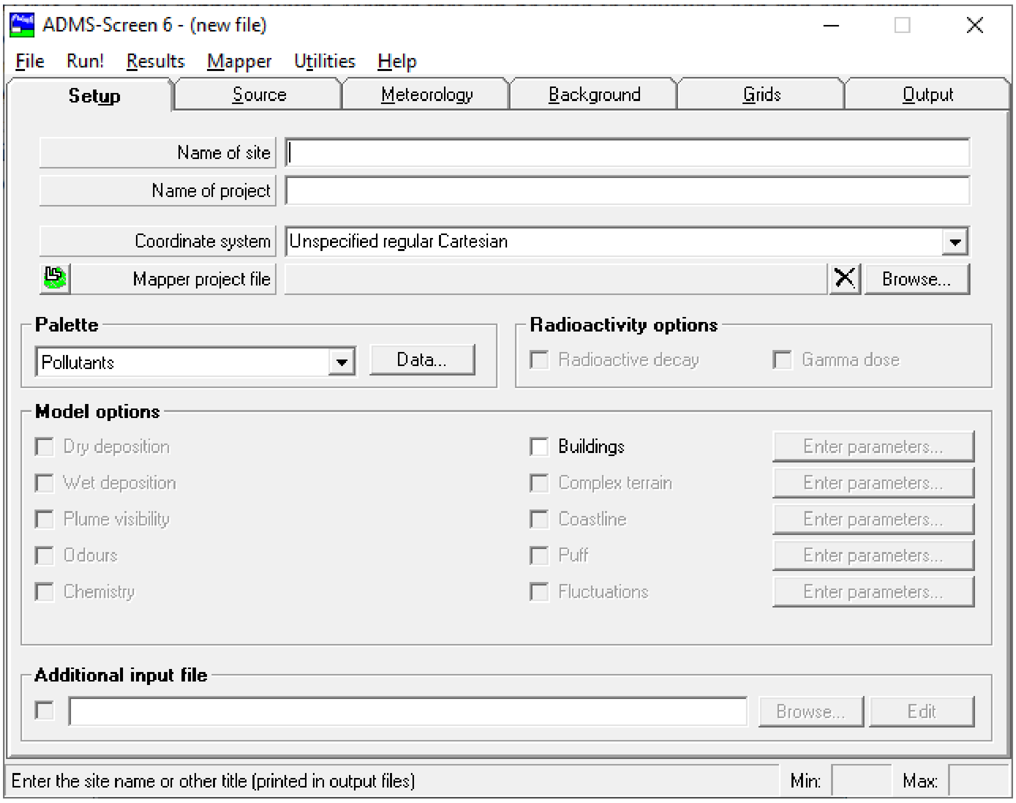

Figure 1.1 – The **Setup** screen of ADMS-Screen showing model options.

What are the main applications of ADMS-Screen?

Typical applications include rapid, or screening, estimates of ground level concentrations due to an individual point source. ADMS-Screen is used by regulators, government departments, industrial companies and consultancies.

Model validation

The model has been extensively validated against field data sets. Since 1992 CERC have been key participants in the series of "Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes" workshops, hosting the 11th Conference in the UK in 2007. The workshops have included validation of models against field data sets, analysis of the validation results and discussion of validation techniques.

Appendix F gives details of validation for ADMS-Screen as well as other publications relevant to ADMS-Screen. Documents describing the latest model validation are available on the CERC website (www.cerc.co.uk).

1.2 Model features

The ADMS-Screen dispersion model calculates long-term and short-term concentrations from a continuous point source. Long-term output can be in terms of averages, rolling averages, percentiles or number of exceedences for direct comparison with air quality objectives and limits. If background ambient concentration data are supplied by the user the output will be the combined concentration due to the process emissions and the ambient concentration, sometimes called the PEC (Predicted Environmental Concentration).

A meteorological processor developed by the UK Met Office is part of the model and calculates values of the meteorological parameters in the boundary-layer required by ADMS-Screen from the input meteorological data.

In addition to the basic model of dispersion over flat terrain ADMS-Screen can model:

- the effect of plume rise;
- the effect of a building;

ADMS-Screen has a number of features to help with the calculation, visualisation and checking of input data, including:

- an integrated Mapper for the visualisation and input of source, building and output location data;
- a tool to visualise in Surfer the location of the source, building, receptors and output grid;
- a verification mode: the *.apl* file created can be verified before it is run to warn the user of errors in input before the full calculations are performed;
- a wind rose plotter;
- a meteorological data converter to convert data supplied in U.S. data formats (NOAA/NCDC surface format or AERMOD *.sfc*) to ADMS-Screen format meteorological data files; and
- the ability to import and export source, pollutant and building data from or to a set of comma-separated files.

1.3 About this User Guide

This *ADMS-Screen User Guide* is both a manual and a technical summary of the model.

Conventions

To make this manual simpler to use, certain conventions have been followed with regard to layout and style.

- ADMS-Screen interface controls are shown in **Arial** font, e.g. the **Grids** screen, click on the **Plot** button.
- Keyboard keys are shown in **bold**, e.g. press **Enter**.
- Directory and file names are shown in *italics*, e.g. *adms.exe*, *<install_path>\Data*.
- Tips and other notes are shown thus:

  Think about the area you want to include in the calculation before specifying the output grid.

- Table and figure references are shown in **bold**, e.g. see **Table 3.2**, **Figure 2.1**.

SECTION 2 Getting Started

2.1 System requirements

ADMS-Screen is supported on Windows 10 and Windows 11 environments. Please visit our website[1] for the latest information regarding computer specifications, supported operating systems and third party software.

2.2 Installation

The installation of ADMS-Screen is straightforward. It uses an Installation Wizard, which guides the user through a short series of screens, collecting information on the user and installation parameters, before installing the software.

Please check with your own IT personnel for company procedures for installing software.

There is a single installation process for ADMS-Screen (version 6) and ADMS 6. Therefore, if you already have ADMS 6 installed on your PC, you will also have ADMS-Screen installed, and only need to install the ADMS-Screen model licence and create a shortcut to ADMS-Screen. Proceed as explained in Section 2.2.1.

If you have earlier versions of ADMS-Screen or ADMS installed on your PC, you should uninstall these models before installing ADMS-Screen 6. Proceed as explained in Section 2.2.2 and then follow instructions given in Section 2.2.3.

If you do not have any version of ADMS-Screen or ADMS installed on your PC, you should follow the instructions in Section 2.2.4.

The abbreviation <install_path> will be used in the rest of the User Guide to denote the directory in which ADMS-Screen and ADMS 6 is installed, for example
C:\Program Files (x86)\CERC\ADMS 6.

2.2.1 Setting up ADMS-Screen 6 if ADMS 6 is already installed

If ADMS 6 is already installed on your PC, please follow these steps:

Step 1 You have been provided with a unique licence file, *A-Screen.lic*, by email, which is required in order to run the model. It is important that you install this licence file by copying the file *A-Screen.lic* to the directory *<install_path>*. Alternatively, drag and drop the licence file into the ADMS 6 interface.

Launching the interface and checking the licence details (through **Help**, **Licence details***) will give the location of the licence currently being used.*

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[1] www.cerc.co.uk/systemrequirements

Step 2 To set up a shortcut to ADMS-Screen on your Windows desktop, browse to the *<install_path>\Support\Shortcuts* directory in Explorer, copy the ADMS-Screen shortcut and paste it on to your desktop.

You are now ready to use ADMS-Screen. Please go to Section 2.2.4.

2.2.2 Earlier versions of ADMS-Screen or ADMS

If you have earlier versions of ADMS-Screen or ADMS installed on your computer, these should be uninstalled before installing ADMS-Screen 6.

To uninstall a previous version, log on as Local Administrator for the PC and click on the Windows **Start** button. From the **Start** menu, select **Settings** and then **Apps**. Select the program name (e.g. ADMS-Screen/ADMS) from the list of installed applications and then click **Uninstall**.

2.2.3 Installing ADMS-Screen

The following steps lead you through the ADMS-Screen installation process.

Step 1 Log on as Local Administrator for the PC.

Step 2 ADMS-Screen will have been supplied by download link. Unzip the downloaded *.zip* file to a local directory.

Do not choose a local directory with an excessively long pathname, as this may cause issues with file pathnames being longer than the allowed maximum of 256 characters.

Step 3 In Explorer, browse to this directory and double-click on the file '*setup.exe*'.

The screen shown in **Figure 2.1** will be launched.

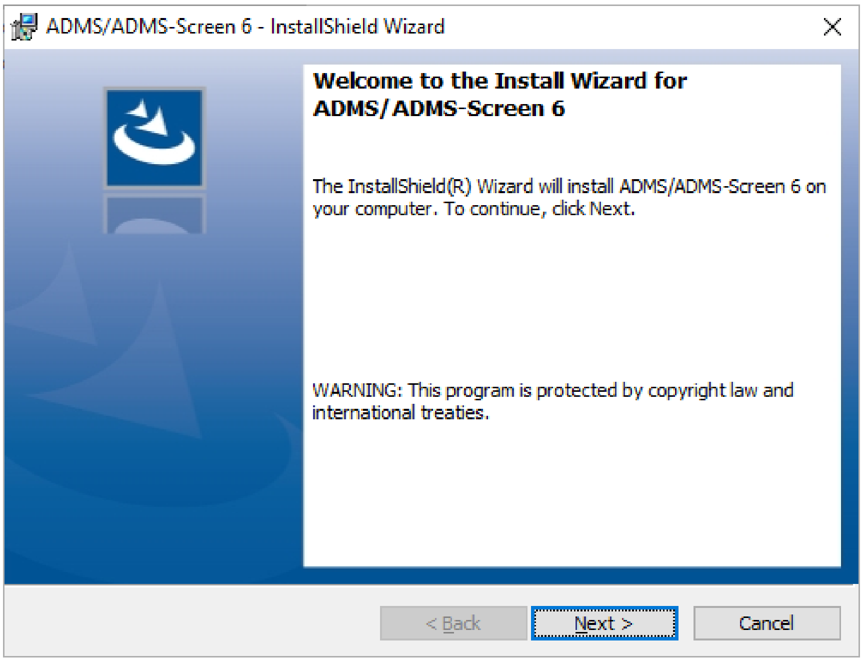


Figure 2.1 – The ADMS-Screen installation **Welcome** screen.

Step 4 Click **Next >** on the **Welcome** screen. Select **I accept the terms of the licence agreement**, and click **Next >** in the **Licence Agreement** screen, if you accept the licence terms. The **Customer Information** screen is then displayed, as shown in **Figure 2.2**. If you do not accept the licence terms select **I do not accept the terms of the licence agreement** and click **Next >** to cancel the installation process.

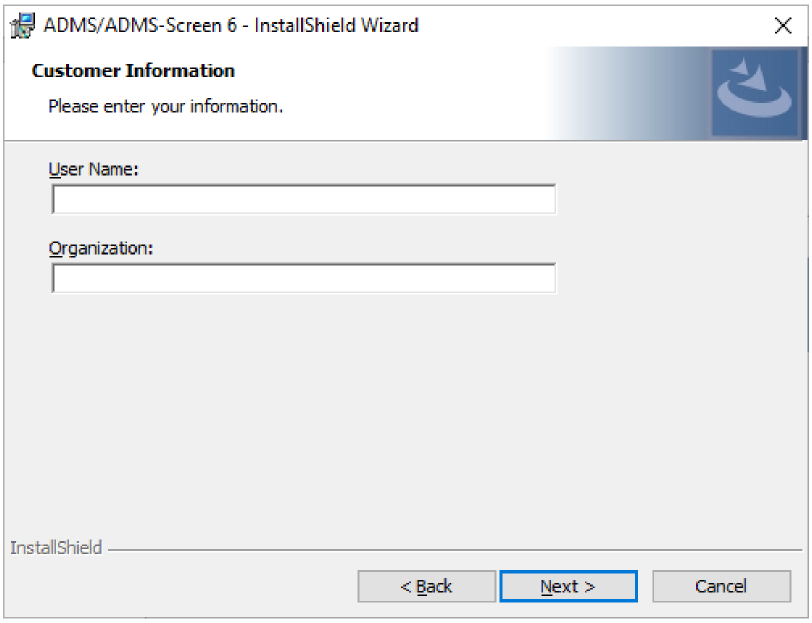


Figure 2.2 – The ADMS-Screen **Customer Information** screen.

Step 5 Enter your user name and organisation in the designated places. Click **Next >** to proceed to the **Destination Folder** screen, as shown in **Figure 2.3**.

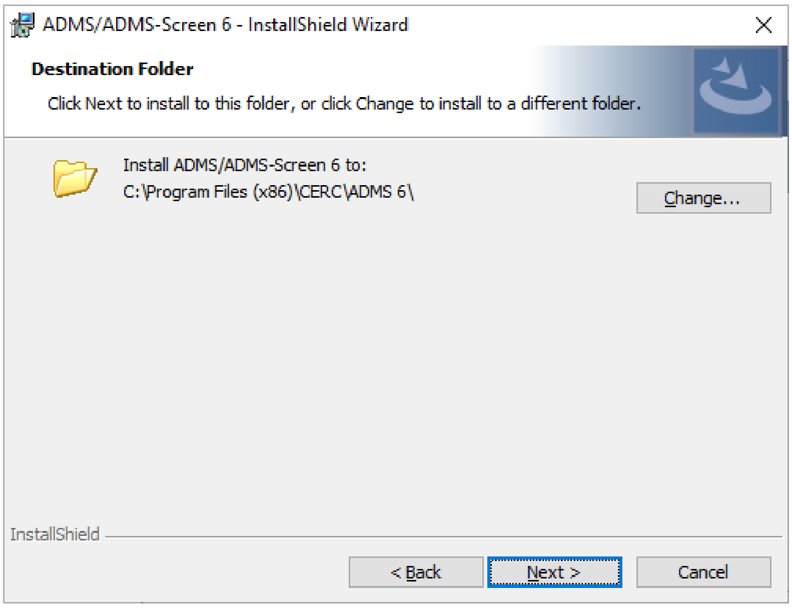


Figure 2.3 – The ADMS-Screen **Destination Folder** screen.

Step 6 You should select a drive with at least 1 GB of available disk space. The default installation directory is *C:\Program Files (x86)\CERC\ADMS 6*. If required, use the **Change...** button to select your own installation directory. Click **OK** to return to the **Destination Folder** screen.

Do not choose an installation directory with an excessively long pathname, as this may cause issues with file pathnames being longer than the allowed maximum of 256 characters.

It is advised to always choose a new installation directory rather than, for example, the directory of a previously uninstalled version of the same software.

Click **Next >** to move to the **Ready to Install the Program** screen, as shown in **Figure 2.4**.

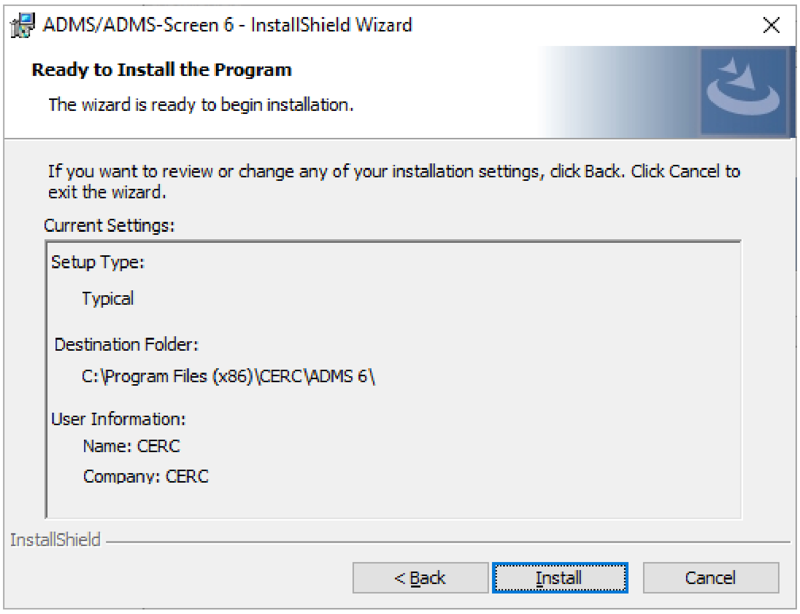


Figure 2.4 – The ADMS-Screen **Ready to Install the Program** screen.

Step 7 If you wish to amend any details, press the **< Back** and **Next >** buttons as appropriate. Once the **Install** button has been pressed, and the ADMS-Screen files have been successfully installed, the final screen will appear, as shown in **Figure 2.5**.

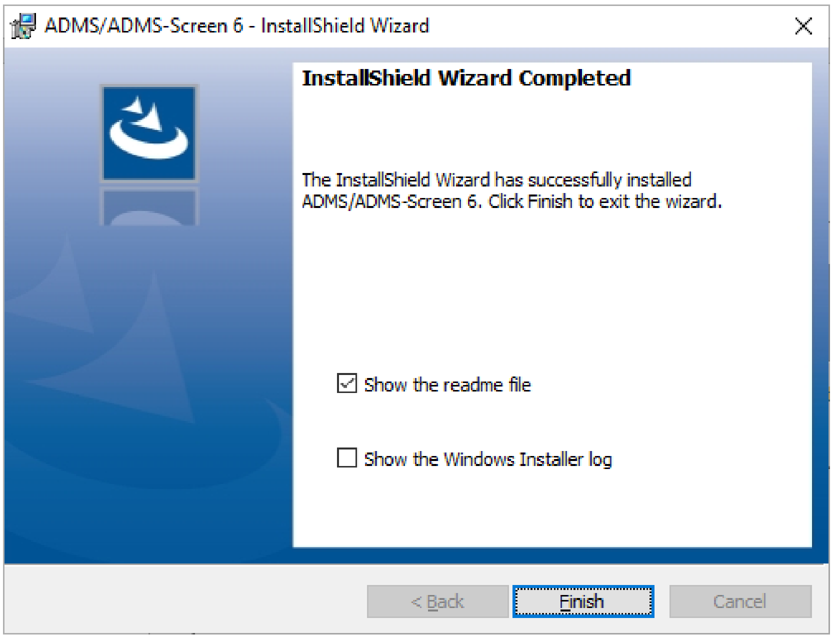


Figure 2.5 – The ADMS-Screen **InstallShield Wizard Completed** screen.

Step 8 Click **Finish** to complete the installation. The installation procedure automatically puts a shortcut to ADMS/ADMS-Screen 6 on your Windows desktop. If the **Show the readme file** box is checked the document *What's New in ADMS 6?* will be opened automatically once you click on **Finish**. This document is specific to ADMS 6; the *What's New in ADMS-Screen 6?* document can be viewed via the **Help, What's New** menu item of the ADMS-Screen interface.

The installation is now complete.

You have been provided with a unique licence file by email, which is required in order to run the model. It is important that you install this new licence file as instructed.

Step 9 To install the ADMS-Screen licence, copy the file *A-Screen.lic* to the *<install_path>* directory.

Step 10 Depending on your licence type, the first time that you launch ADMS-Screen after installation, it may be necessary to be connected to the Internet so that your licence can be registered. If there is no Internet connection, the message shown in **Figure 2.6** will appear.

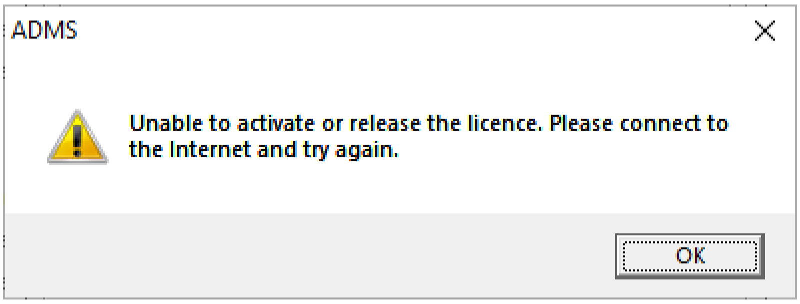


Figure 2.6 – Licence registration failure.

Step 11 Your licence type will allow up to a certain number of users. Depending on the licence type, if the maximum number of users has already been reached, the message shown in **Figure 2.7** will appear. If you are issued this message, it is first necessary to release another user's licence (via the **Help, Return licence** menu item of the ADMS-Screen interface on that user's PC) before launching ADMS-Screen again on the current PC.

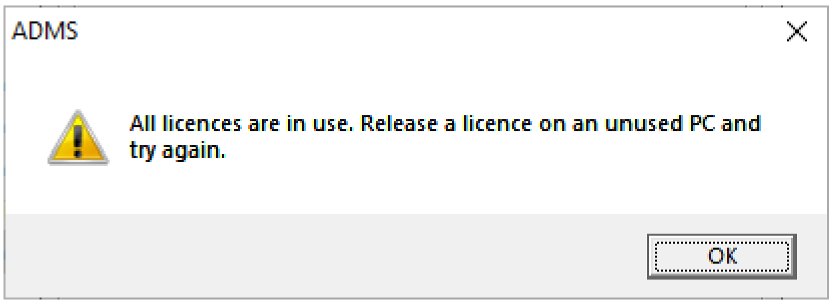


Figure 2.7 – All licences in use.

Step 12 The first time you start the model you will be presented with a choice of models, as shown in **Figure 2.8** , ensure ADMS-Screen is selected and click **OK**.

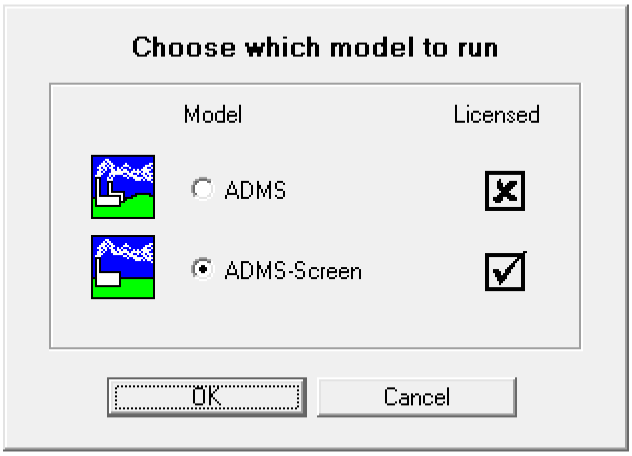


Figure 2.8 – The model choice screen.

Launching ADMS-Screen and checking the licence details (though **Help, Licence details***) will give the location of the licence currently being used.*

If ADMS-Screen is already installed and you are simply renewing an expired licence, it is also possible to drag and drop the new licence file into the ADMS-Screen interface in order to automatically install the new licence.

2.2.4 Installing the ADMS GIS extension

If you will be using ADMS-Screen in conjunction with the GIS packages ArcGIS or MapInfo, you should install the extension now. The installations for the extensions will have been copied to the *<install_path>\Support* directory. Further instructions for installing these links can be found in their respective User Guides in the *<install_path>\Documents* directory.

2.3 Getting around the interface

2.3.1 Mouse buttons

Unless otherwise stated, mouse instructions refer to the left button. If the mouse options have been used to reverse the mapping (e.g. because you are left-handed), the right mouse button should be used instead.

2.3.2 Keyboard access

Most of the mouse instructions in this manual can be reproduced using keystrokes. A brief guide to these keystrokes is given in **Table 2.1**.

Also known as shortcut keys, these are combinations of keys that perform some of the main commands. For example, menu commands that have one letter underlined are accessible by holding down the **ALT** key and then typing the underlined letter. For example, the menu command **Open...** located on the **File** menu, may be executed by typing **ALT + F** and then **ALT + O**.

Key	Description
Moving the cursor between data entry boxes	
TAB	Move the cursor forwards through data entry boxes or buttons
SHIFT + TAB	Move the cursor backwards through data entry boxes and buttons
RETURN	'Enter' or accept the current data page or execute the action of a highlighted button
SPACEBAR	Select or deselect the highlighted option
Entering data in a box	
DELETE	Delete the character immediately to the right of the cursor
BACKSPACE	Delete the character immediately to the left of the cursor
← arrow	Move the cursor one space to the left in the current box
→ arrow	Move the cursor one space to the right in the current box
SHIFT + arrow	Begin highlighting characters in the direction of the arrow (see above)
Highlighted text	
DELETE	Delete all highlighted characters
(Type)	Typing text replaces the highlighted text with new text
Radio buttons	
← arrow	Move the cursor up through the radio buttons for the current item
→ arrow	Move the cursor down through the radio buttons for the current item

Table 2.1 − Keystrokes to enable you to move through the ADMS-Screen interface.

2.4 Main menu options

The menu bar has six headings: **File**, **Run!**, **Results**, **Mapper**, **Utilities** and **Help**. All menu headings apart from the **Run!** and **Mapper** have drop-down lists of options (see for example the **File** menu options shown in **Figure 2.9**). **Table 2.2** gives the list of options and roles of each menu item.

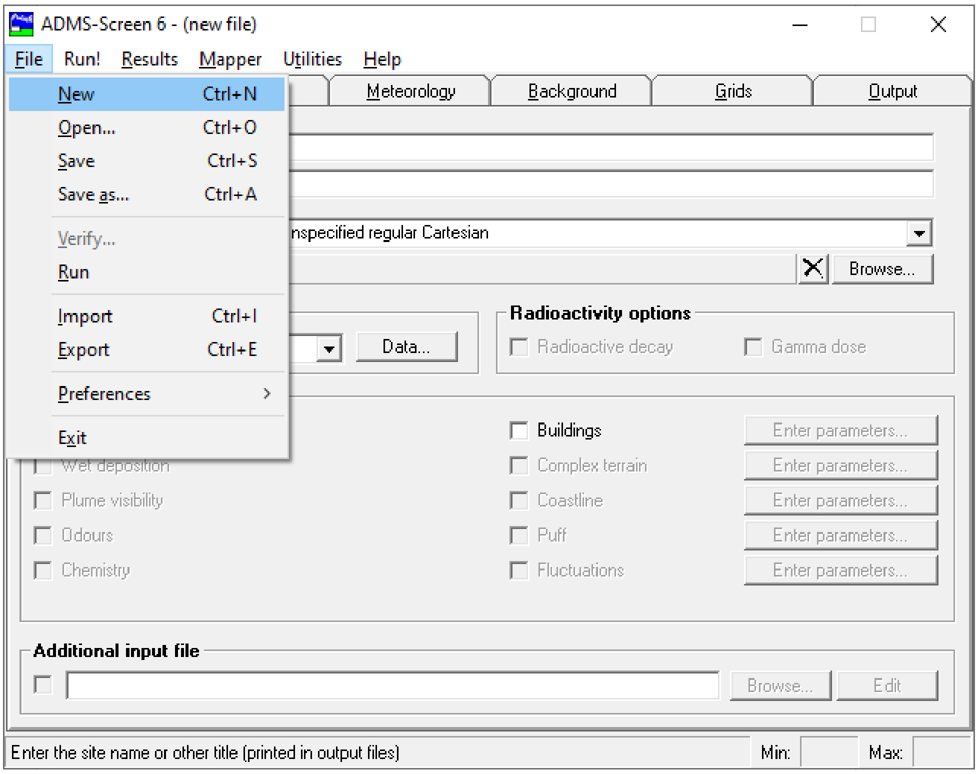


Figure 2.9 – The **File** menu from the menu bar in ADMS-Screen.

Menu			Role	Ref.
File	New		Reset the parameters in the *.apl* file to their default values	
	Open…		Open a previously saved parameter file	
	Save		Save the current parameters under the current file name	
	Save as…		Save the current parameters with a user-specified file name	
	Verify…		Run verification checks on the *.apl* file	2.5.5
	Run		Check the validity of the input data and run the ADMS-Screen code using the current parameter file	2.5.6
	Import		Import source, pollutant and building data from a set of comma-separated input files	5.2
	Export		Export source, pollutant and building data to a set of comma-separated input files	5.3
	Preferences	Percentiles method	Force the model to use one of the available percentiles methods (normally, the model chooses the method)	
	Preferences	APL verification	Change the settings that affect when APL verification should run and how the results of APL verification should be presented	2.5.5
	Preferences	Model execution	Choose options for the run time window state and exit mode	2.5.6
	Preferences	Viewing options	Choose the application for viewing numerical results files in ADMS-Screen (the default application is Microsoft Excel)	6.5
	Preferences	Coordinate system	Specify the coordinate system to be used by default	3.1.2
	Preferences	Licence management	Specify whether the online licence should be released automatically when ADMS-Screen is closed. (Only visible for some licence types).	
	Preferences	Start As	Choose the product mode to run	
	Exit		Quit ADMS-Screen	
	1, …		Show the names of the *.apl* files most recently opened in ADMS-Screen (click on the required file name to open the selected file in ADMS-Screen)	
Run!			Check the validity of the input data and run the ADMS-Screen code using the current *.apl* file	2.5.6
Results	Contour plot	Mapper	Launch the 2-D Output Plotter for plotting contours in the Mapper	6.2
	Contour plot	Surfer	Launch the 2-D Output Plotter for plotting contours in Surfer (if Surfer is installed)	6.2
	Flow field plot	Mapper	Not applicable to ADMS-Screen	
	Flow field plot	Surfer	Not applicable to ADMS-Screen	
	Line plot		Launch the line plotting facility	6.3
	Display footprint		Not applicable to ADMS-Screen	
	Log files		Show the verification report and/or other information output files for the current *.apl* file	6.4

Table 2.2 − Options and roles of menu items. The last column (Ref.) indicates the section of the user guide where the item is further described.

Menu		Role	Ref.
Results	Numerical output	Open the numerical output of the current *.apl* file in the preferred viewing software	6.5
	Results folder	Open the folder containing the *.apl* file in an Explorer window	
	Automate Surfer contour plots	Launch an Excel template containing macros for the automation of contour plotting in Surfer (if Surfer and Excel are installed)	*
	Make Slideshow	Launch an Excel template containing macros for creating a slideshow (if Excel is installed)	*
Mapper		Launch the ADMS Mapper	7.1
Utilities	View a wind rose	Launch the Wind Rose viewer	7.2
	Visualise Input in Surfer…	Select features in the current *.apl* file, such as location of the source, for visualisation in a Surfer plot (if Surfer is installed)	7.2
	Create/Run batch file…	Create and run batch files	7.4
	Convert met. data	Convert US format met. data to ADMS format	7.4
	Create ASP grid	Not applicable to ADMS-Screen	
	Create import templates	Create templates for the import facility	5.1.6
	Start Excel	Launch Excel (if Excel is installed)	
	Start Surfer	Launch Surfer plotting package (if Surfer is installed)	
Help	User Guide	Open the User Guide in a PDF viewer	
	What's New	Open the *What's New* in a PDF viewer	
	Contact helpdesk	Auto-addresses a new email to the ADMS-Screen helpdesk in the user's default email client	
	CERC website	Opens the CERC homepage in the user's default internet browser	
	Licence details	Show licensee and licence number of the model	
	Return licence	Releases the licence from the PC so it can be registered by another PC. (Only visible for some licence types).	
	About model	Show model version number along with contact information for CERC and the ADMS-Screen Helpdesk	

Table 2.2 − Options and roles of menu items. The last column (Ref.) indicates the section of the user guide where the item is further described. *(continued)* * Please refer to the *Surfer Automation and Slideshow Creator Tools User Guide* for more details.

2.5 Creating a model file and running the model

To generate results using ADMS-Screen, there are several steps to complete:

- create a new model file,
- enter data to define the problem,
- save the model file,
- verify the model file,
- run the model,
- display the output.

The first four of these steps are described in Sections 2.5.1 to 2.5.5. Entering model data is described in general terms here, and in full detail in Sections 3 and 4. Displaying model output is covered in detail in Section 6.

2.5.1 Creating or opening an existing a model file

When the ADMS-Screen model interface is loaded or when you select the **New** command from the **File** menu, a new model file, or scenario, is created and default values are loaded into the screens for you to edit.

An existing model file for editing or running can be opened either in the ADMS-Screen model interface or from Explorer.

- To open a model file in the ADMS-Screen interface, choose **Open...** from the **File** menu. (By default, ADMS-Screen will only display files with the *.apl* extension.)
- To open a model file from Explorer, either
  - ∗ right-click on the file and select **Open with ADMS**, or
  - ∗ drag and drop the file onto the title bar of the ADMS-Screen interface, or
  - ∗ double click on the file.

Files prepared in previous recent versions of ADMS-Screen are converted into the current ADMS-Screen format as they are loaded into the interface. Simply open the file you wish to convert, by selecting ***Open...*** *from the* ***File*** *menu, and follow the instructions given on screen.*

It is possible to have multiple instances of the ADMS-Screen interface open simultaneously. This is particularly useful for comparing two model files side by side. Individual model input files (.apl) should never be open in more than one instance of the interface simultaneously.

2.5.2 Entering information

Changing values in the input screens

To change a parameter value in an input screen, move the pointer until it is over the appropriate text box and click. Alternatively, use the **TAB** or **arrow keys** to move systematically through the sections contained in each screen. The selected area will be highlighted. Now type the new value, which will automatically replace what was highlighted. Alternatively, use **DELETE** and/or **BACKSPACE** to remove unwanted characters before typing in the new value.

Note that a blank cell does not denote a value of zero.

The helpline

This is a single line of text that appears at the bottom of the active screen. The information in the helpline changes when different controls on the screen are selected. It gives a brief description of the selected control's function. Where you are prompted for a numerical value, the helpline will give the minimum and maximum values allowed.

For example, when the **Latitude (°)** box in the **Meteorology** screen is selected, the help bar will display the line:

Approximate latitude of the source site (°), Min: -90, Max: 90

Data validity and integrity checking

As you enter data, the ADMS-Screen model interface performs checks to ensure that all user-entered data are consistent with the model's logic and that minimum and maximum values are satisfied.

2.5.3 Saving input data to a model file

When you are ready to run the model, choose **Save** from the **File** menu. If the current scenario has not been saved before, you will be prompted to choose a directory and file name. ADMS-Screen model files are always saved with the extension *.apl*.

2.5.4 Additional model input files

One additional model input file may be required by the model in order to run, this is the *.met* file which contains the meteorological data required by the ADMS-Screen met pre-processor. The *.met* file is a comma delimited file in a particular format.

The user can **Browse...** to locate the *.met* input file, the absolute paths of the files are automatically written to the ADMS-Screen model *.apl* file.

If you use Excel to save a .met input file in comma-delimited format, it is important to open it in a text editor such as Notepad, remove any trailing commas, and re-save it, prior to use by the model.

2.5.5 Verifying the model file

An option exists to verify the contents of an *.apl* file. This carries out all of the model data checks, runs the meteorological pre-processor, and produces a report file, but stops before calculating concentrations. It is therefore quick to run, providing a useful check of the modelling input data before the main run.

While running APL verification, the model will carry on past as many errors as it can so as to produce as comprehensive a list of errors as possible. Select **File**, **Verify…** to run APL verification.

Additionally, the ADMS-Screen interface can be set so that the *.apl* file is verified each time it is saved and also before the model is run. To alter these settings select **File, Preferences**, **APL verification**. This will bring up the **Data file verification preferences** screen, shown in **Figure 2.10**.

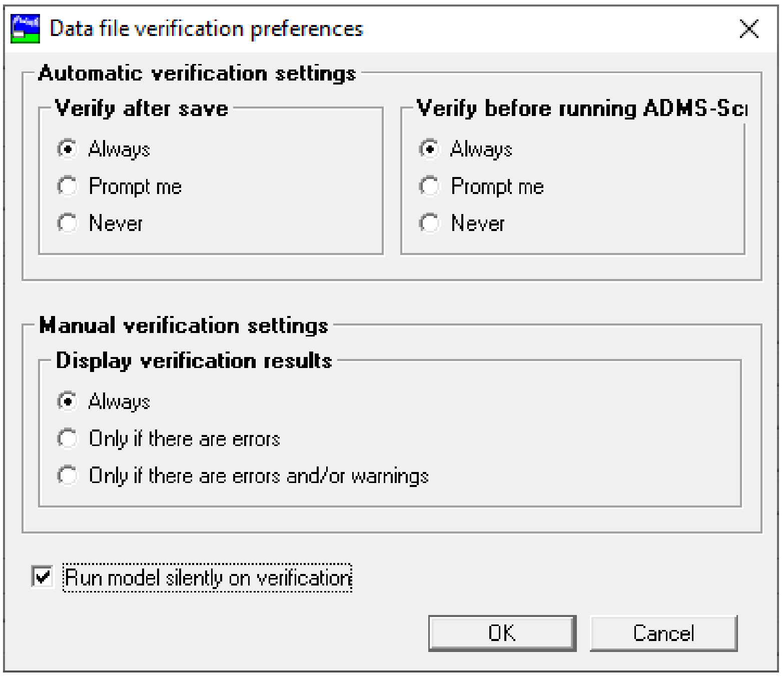


Figure 2.10 – The **Data file verification preferences** screen.

From this screen there are four options that can be set:

- **Verify data after save**: determines whether APL verification should be carried out each time the *.apl* file is saved. Verification results are only displayed if any errors are found.
- **Verify data before run**: determines whether APL verification should be carried out each time before the model is run. Verification results are only displayed if any errors are found. If no errors are found, the model then runs as normal.
- **Display verification results**: if APL verification is selected manually from the **File** menu, these settings select when the results should be shown.
- **Run model silently on verification**: if checked, the APL verification will run the model minimised and the run window will automatically close when verification has finished (default option).

2.5.6 Running ADMS-Screen

Save the current scenario as an *.apl* file, then select **Run!** from the menu bar to run the model (or select **Run** from the **File** menu). If you have never saved the current scenario or if you have changed anything in the interface since the scenario was last saved, then you will be prompted to save the modifications.

Alternatively, you can run the model with a batch file. Such a file allows you to run several files consecutively without opening and running each *.apl* separately. Batch files can be created with the **Make/Run Batch File** utility (see Section 7.4).

While the model is running, information is displayed in a progress window (see **Figure 2.11**) to show the status of the model run in terms of the number of lines of meteorological data completed. When all the calculations have successfully completed, the progress window displays "`***RUN SUCCESSFULLY COMPLETED***`".

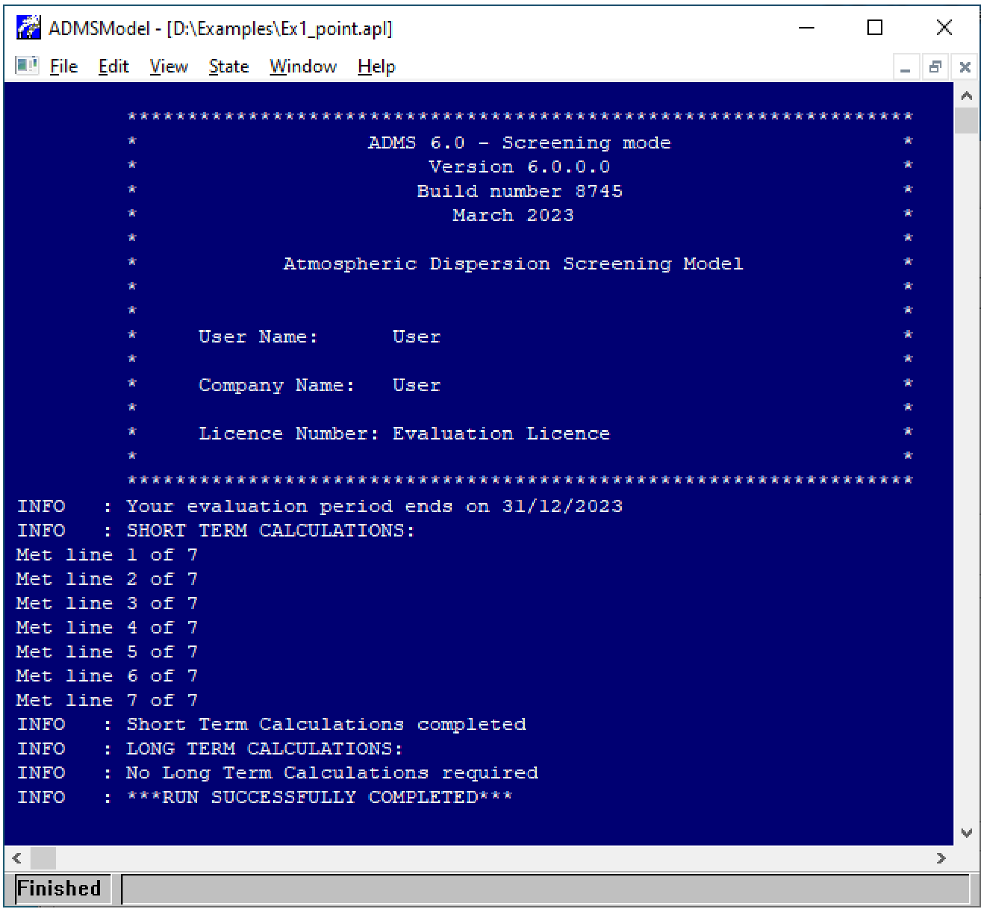


Figure 2.11 – Progress window of an ADMS-Screen run.

Runtime preferences

The user can edit the runtime options from the **File**, **Preferences, Model execution** menu. This will bring up the **Runtime Preferences** screen shown in **Figure 2.12**, divided into two sections:

- The **Window State Options** control the size and state of the run window: normal, minimized or maximised, with focus (active window) or without focus.
- The **Exit Mode Options** determine whether the run window closes after the run

has completed. If **Normal termination box** is selected, a dialogue box appears at the end of the run asking whether you want the window to close. If **No termination box, window open** is selected, no dialogue box is displayed and the progress window is kept open at the end of the run. If **No termination box, window closes** is selected, no dialogue box is displayed and the progress window is closed at the end of the run.

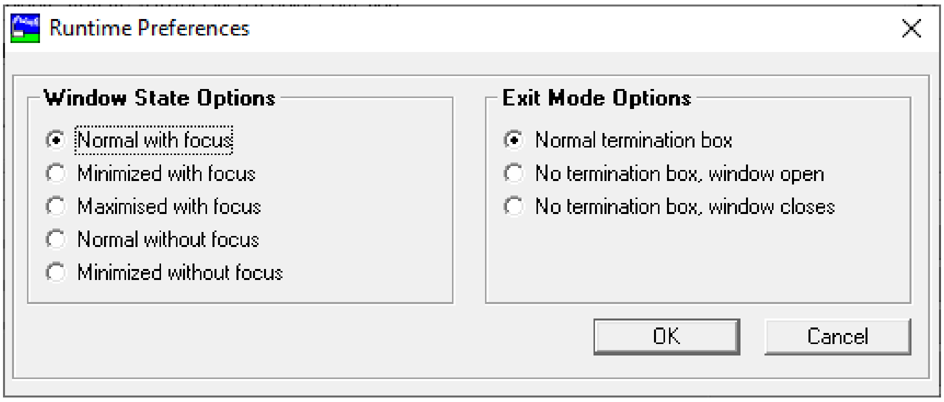


Figure 2.12 – Runtime Preferences screen.

2.5.7 Displaying model output

Please refer to Section 6 for details about displaying output from ADMS-Screen model runs.

SECTION 3 Model Input

Setting up a modelling problem requires the user to input information specifying the release conditions, meteorological conditions and details of the output required. This section provides an overall guide to the model interface. It describes the minimum input data required to run the model and briefly presents the additional modelling options available (full details on these options can be found in Section 4). Sections 3.1 to 3.6 detail each type of input data. Practice in use of the model is given in Section 8 in two detailed worked examples.

There are six basic input screens associated with an ADMS-Screen model run, as shown in **Figure 3.1**. Data must be entered into each of these basic screens for every model run. These are:

- **Setup**: general site details and modelling options to be used;
- **Source**: source dimension and location, release conditions, emissions;
- **Meteorology**: meteorological conditions;
- **Background**: background data;
- **Grids**: grid and/or specified point locations for output; and
- **Output**: output required from the calculations.

It is advisable (though not necessary) to enter data in the screen order from left to right on the interface, namely **Setup**, **Source**, **Meteorology**, **Background**, **Grids** and **Output**.

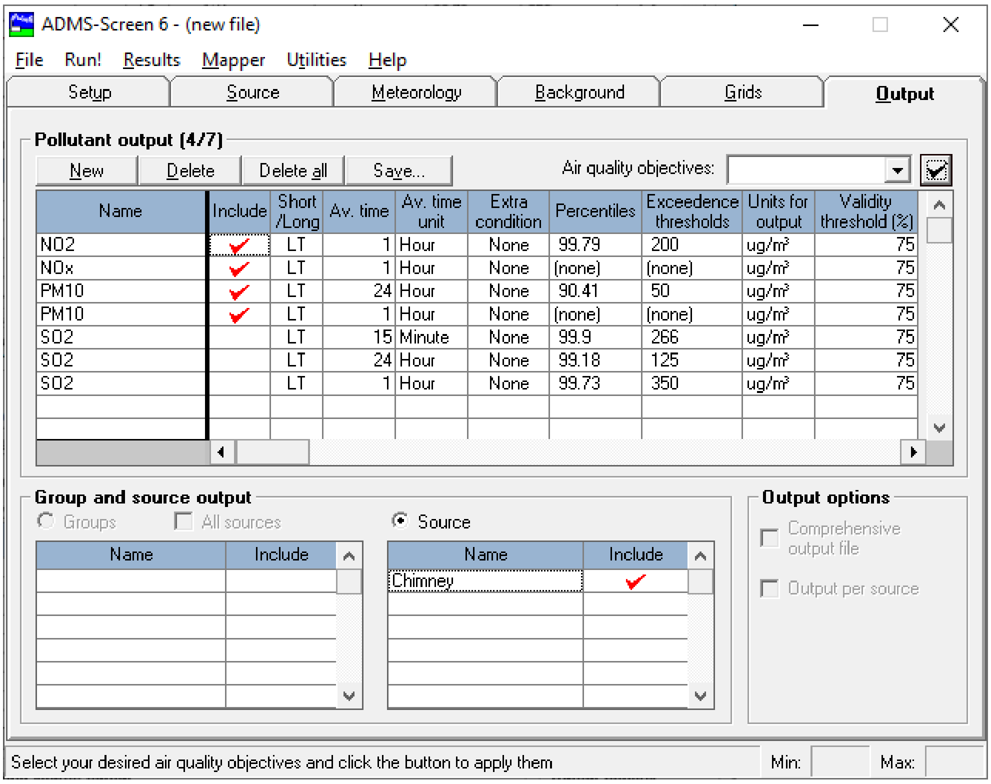


Figure 3.1 – The ADMS-Screen interface.

3.1 Setup screen

The **Setup** screen is shown in **Figure 3.2**, and is the screen that appears when ADMS-Screen is first opened. The general site details, pollutant information and building details are entered here.

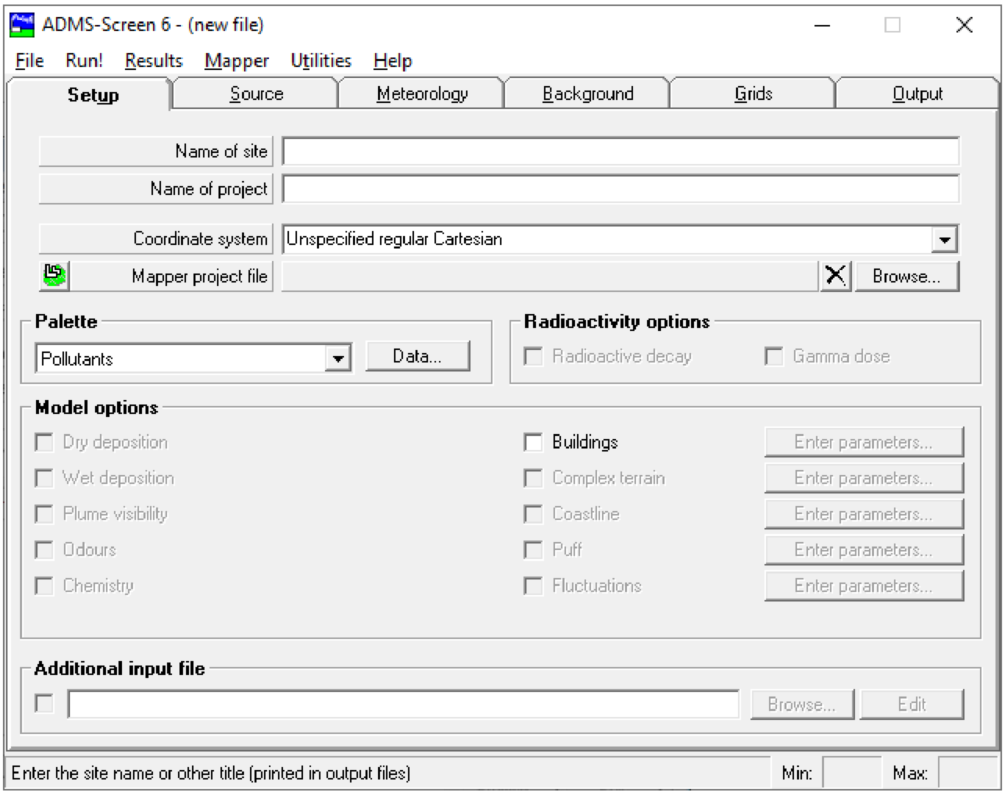


Figure 3.2 – The **Setup** screen.

3.1.1 Name of site, Name of project

Up to 80 characters may be entered for each of these, or the boxes may be left empty. Text entered here will appear in the output "report" file, so it is recommended that meaningful entries are included each time.

3.1.2 Coordinate system

Spatial data entered into ADMS-Screen should be in a Cartesian coordinate system, measured in metres. The coordinate system may either be a standard coordinate system, e.g. British National Grid, or site-specific, e.g. centred on the source. The **Coordinate system** should be selected from the list, if a site-specific coordinate system is being used then select **Unspecified regular Cartesian**. To match a custom coordinate system specified in the Mapper select **Use Map coordinate system**. The coordinate system is used by the Mapper and for some export options a recognised coordinate system must be used, for more information refer to the *Mapper User Guide*.

The default coordinate system used for a new file can be specified from the ***File****,* ***Preferences****,* ***Coordinate system*** *menu option.*

When using a projected coordinate system, it is important to choose one that is well suited to the geographic location of the study site, i.e. one that does not result in significant distortion of distances and/or orientation. For example, a global Mercator projection (e.g. 'Sphere Mercator (epsg:53004)') is only well suited to regains close to the equator; using this projection for a site in, say, central England would result in an inflation of distances of around 65%.

3.1.3 Mapper project file

The **Mapper project file** describes how to display information in the Mapper, refer to Section 2.1 in the Mapper User Guide for more details. The Mapper project file can be changed either by using the **Browse** button or from the Mapper. The  button can be used to launch the Mapper.

3.1.4 Model options

The box presents a choice of modelling options to be used in the ADMS-Screen run. The only option available to ADMS-Screen users is whether or not to include a building. This option is fully described in Section 4.

If no model option is selected, then ADMS-Screen will calculate concentrations for a continuous (plume) release in flat terrain.

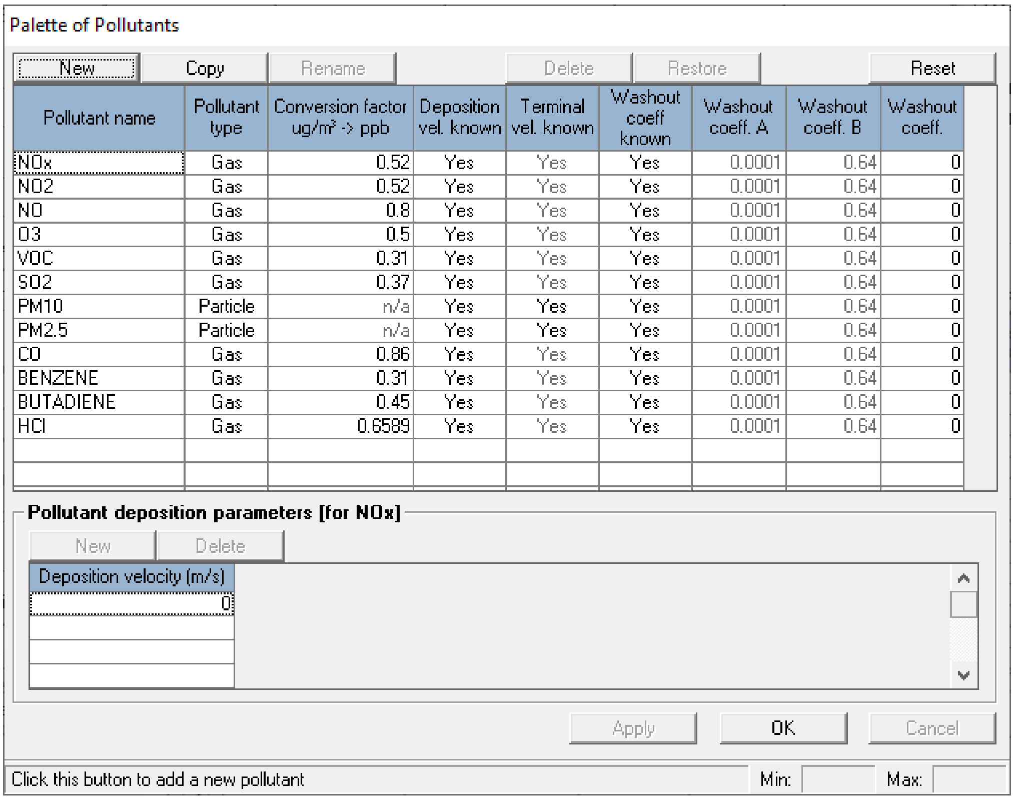
3.1.5 Palette

The **Data...** button brings up the **Palette of Pollutants** screen which is shown in **Figure 3.3**. The **Palette of Pollutants** screen can also be accessed by clicking on **Pollutants...** in the **Emissions** screen; see Section 3.2.4.

The purpose of the palette of pollutants is to define properties of pollutants for a given problem. Up to 100 pollutants may be defined: 12 pollutants are pre-defined, namely NO_X, NO_2, NO, O_3, VOC (volatile organic compound), SO_2, CO, benzene, butadiene and HCl (hydrogen chloride) together with the generic particulates PM_{10} and $PM_{2.5}$. NO_X, NO_2, NO, O_3 and VOC may not be deleted from the palette.

The **New** and **Delete** buttons are used to add new pollutants to the palette and remove existing ones, respectively. The **Rename** button is used to change the name of existing pollutants. The **Copy** button can be used to create a copy of an existing pollutant. When pollutants are deleted they remain in the palette marked in red until the **Apply** or **OK** buttons are clicked. While the deleted pollutant remains in the palette the pollutant is no longer editable but can be restored to full functionality using the **Restore** button.

The **Reset** button restores the palette to its default contents (including the removal of user-defined pollutants).



Pollutant name	Pollutant type	Conversion factor ug/m³ -> ppb	Deposition vel. known	Terminal vel. known	Washout coeff known	Washout coeff. A	Washout coeff. B	Washout coeff.
NOx	Gas	0.52	Yes	Yes	Yes	0.0001	0.64	0
NO2	Gas	0.52	Yes	Yes	Yes	0.0001	0.64	0
NO	Gas	0.8	Yes	Yes	Yes	0.0001	0.64	0
O3	Gas	0.5	Yes	Yes	Yes	0.0001	0.64	0
VOC	Gas	0.31	Yes	Yes	Yes	0.0001	0.64	0
SO2	Gas	0.37	Yes	Yes	Yes	0.0001	0.64	0
PM10	Particle	n/a	Yes	Yes	Yes	0.0001	0.64	0
PM2.5	Particle	n/a	Yes	Yes	Yes	0.0001	0.64	0
CO	Gas	0.86	Yes	Yes	Yes	0.0001	0.64	0
BENZENE	Gas	0.31	Yes	Yes	Yes	0.0001	0.64	0
BUTADIENE	Gas	0.45	Yes	Yes	Yes	0.0001	0.64	0
HCl	Gas	0.6589	Yes	Yes	Yes	0.0001	0.64	0

Figure 3.3 – Palette of pollutants in ADMS-Screen, showing default values for the pre-set pollutants.

The palette requires definition of a number of parameters related to each pollutant:

1. **Pollutant name**

   Each pollutant must have a unique name before the information may be saved. The pollutant name must not contain commas and must contain no more than 30 characters.

2. **Pollutant type**: **Gas** (for gaseous emissions) or **Particle** (for particulates)

   Double-click in the **Pollutant type** column to change between **Gas** and **Particle.** The number of columns in the lower table changes according to the different options in the upper table (see 4).

3. **Conversion factor (ug/m³ → ppb)**

   For gaseous pollutants, the user should specify a factor to convert output concentrations from μg/m^3 to parts per billion by volume (ppb). The conversion factor from μg/m^3 to ppb is 24.06/M (derived from the Ideal Gas Equation), where M is the molecular mass of the pollutant in grams. Default values:

   User-defined pollutant = 1 (Gas) or n/a (Particle)

4. **Dry deposition parameters**

   The lower table in the palette gives parameters that are related to dry deposition processes. Dry deposition is not modelled in ADMS-Screen and these parameters should be left as the default values.

5. **Wet deposition parameters**

The parameters in the last four columns of the upper table of the palette (**Washout coeff known**, etc.) are related to wet deposition processes. Wet deposition is not modelled in ADMS-Screen and these parameters should be left as the default values.

3.2 Source screen

The **Source** screen is shown in **Figure 3.4** as it appears for a new model run. All source properties are entered here: dimensions, location, pollutants, etc.

3.2.1 Sources

The **Source** screen allows the user to add a source. Data may only be entered for a single source. Select **Sources**, and create or delete a source using the **New** and **Delete** buttons. Clicking on **New** will enter a new line of data in the table with default values, which may then be edited to meet the requirements of the problem.

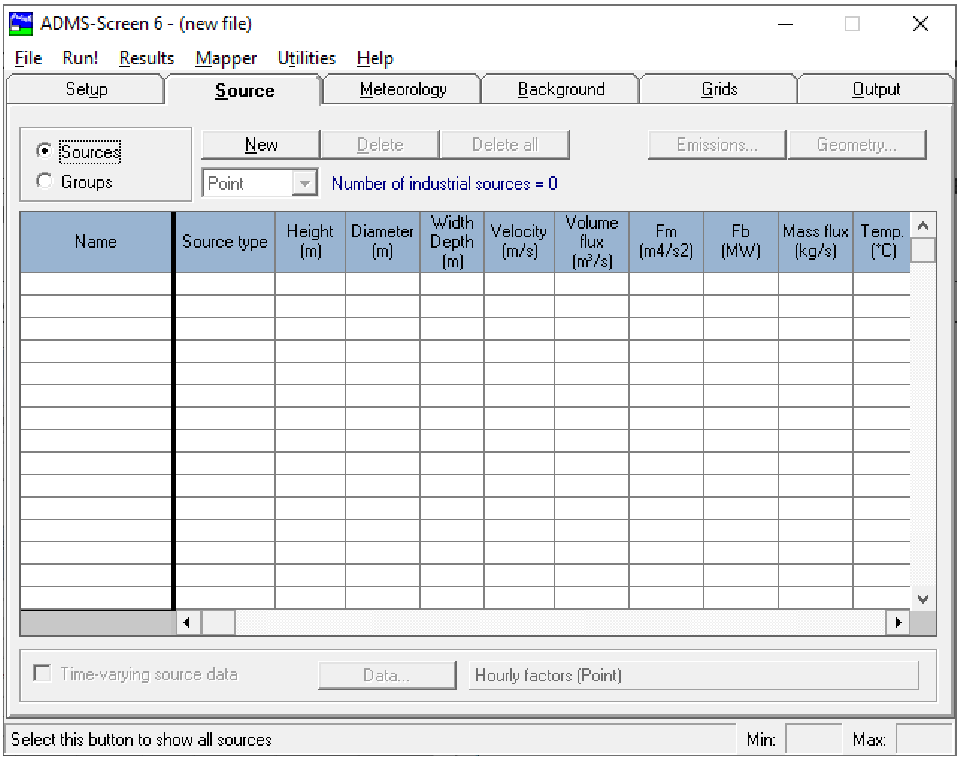


Figure 3.4 – The **Source** screen.

3.2.2 Source data

Data for an individual source should be entered in the table shown in **Figure 3.4**. The list of parameters that may be entered for the source is given hereafter. Some parameters should be entered by hand, others chosen from a drop-down menu and others modified by clicking on the displayed value.

1. **Name**: it is advised to give a meaningful source name for the study, for example "incinerator". By default, a name such as Source00001 is used. The source name must not contain commas and must contain no more than 30 characters.

2. **Source type**: type of the source.

   Note that only a **Point** source may be modelled in ADMS-Screen.

3. **Height (m)**: height of source above the ground.

   Minimum = 0 m
   Maximum = 15 000 m
   Default = 50 m

4. **Diameter (m)**: internal diameter of the source.

   Minimum = 0.001 m
   Maximum = 100 m
   Default = 1 m

5. **Width Depth (m)**: Not used in ADMS-Screen

6. **Velocity (m/s)**: velocity of release at source exit (in m/s if **Actual** is selected in 17 or in Nm/s if **NTP** is selected where N means normal pressure and temperature).

   Minimum = 0 m/s
   Maximum = 1 000 m/s
   Default = 15 m/s

7. **Volume flux (m^3/s)**: volume flow rate of the release (in m^3/s if **Actual** is selected in 17 or in Nm^3/s if **NTP** is selected).

   Minimum = 0 m^3/s
   Maximum = 10^9 m^3/s
   Default = 11.781 m^3/s

8. **Fm (m4/s2)**: momentum flux of release as defined in the HMIP D1 document (HMIP, 1993). **Fm** should always be specified at the release conditions, i.e. **Actual** temperature and pressure. Refer to Section 9.9 for more information.

   Minimum = 1 m^4/s^2
   Maximum = 10^6 m^4/s^2
   Default = 1 m^4/s^2

9. **Fb (MW)**: heat release rate of release as defined in the HMIP D1 document (HMIP, 1993). **Fb** should always be specified at the release conditions, i.e. **Actual** temperature and pressure. Refer to Section 9.9 for more information.

   Minimum = 0.0001 MW
   Maximum = 10^4 MW
   Default = 1 MW

10. **Mass flux (kg/s)**: mass flux of the release.

    Minimum = 0.1 kg/s
    Maximum = 10^5 kg/s
    Default = 1 kg/s

11. **Temp. (°C)**: temperature of the release.

    Minimum = -100°C
    Maximum = 5 000°C
    Default = 15°C

12. **Density (kg/m³)**: density of the release material.

    Minimum = 0.01 kg/m^3
    Maximum = 2 kg/m^3
    Default = 1.225 kg/m^3 (typical value for air)

13. **X (m)**, **Y (m)**: X and Y coordinates of the centre of a point source.

    Minimum = -9 999 999 m
    Maximum = 9 999 999 m
    Default = 0 m

    The large magnitude of the minimum and maximum values allows the user to input UK National Grid coordinates or the worldwide Universal Transverse Mercator coordinates (UTM).

14. **Angle 1 (°), Angle 2 (°)**: Not used in ADMS-Screen

15. **T, RHO or Ambient?**: temperature or density of the release. Type **T** to enter a (constant) temperature (**T**), **R** to enter a density (**RHO**), or **A** if the release is at ambient temperature and density (**Ambient**).

    Default = **T**

    *This setting can also be changed by right-clicking in either the **Temp. (°C)** or **Density (kg/m³)** columns.*

16. **Efflux**: efflux format option to be used in the calculation.

    Exit V. exit velocity
    Vol. volumetric flow rate
    Fm, Fb momentum flux and heat release rate (for example for fires)
    Mass mass flow rate

    Default = **Exit V.**

    *This setting can also be changed by right-clicking in an any of the **Velocity (m/s)**, **Volume flux (m³/s)**, **Fm (m4/s2)**, **Fb (MW)** or **Mass flux (kg/s)** columns.*

17. **Actual or NTP**: emission parameters are given at normal temperature and pressure (NTP = 1 atm and 273.15 K) or at the actual release temperature and pressure.

    Default = **Actual**

18. **Cp (J/°C/kg)**: specific heat capacity of the whole release.

    Minimum = 1 J/kg/°C
    Maximum = 10^5 J/kg/°C
    Default = 1 012 J/kg/°C (typical value for air)

19. **Mol. mass (g)**: molecular mass of the whole release (mass of one mole of the material).

    Minimum = 1 g

Maximum = 300 g
Default = 28.966 g (typical value for air)

20. **Main building**: if a building is being modelled, then the building defined is selected as the main building for the source.

The source **name** (1), **source type** (2), **height** (3), **diameter** (4), **X** and **Y** coordinates (13) and **efflux** type (16) should always be entered. Efflux parameters 6 to 12 and 15 to 17 should be specified as summarised in **Table 3.1**.

Default values (those for air) would normally be used for parameters **Cp** (18) and **Mol. Mass** (19) unless a very pure gas is being emitted. If **Cp** and **Mol. Mass** are being altered it must be ensured that these two parameters are set to consistent values.

Efflux type	Actual or NTP	Velocity	Volume flux	T or RHO	Fm	Fb	Mass Flux
Exit V.	✓	✓	✗	✓	✗	✗	✗
Vol.	✓	✗	✓	✓	✗	✗	✗
Fm, Fb	✗	✗	✗	✗	✓	✓	✗
Mass	✓	✗	✗	✓	✗	✗	✓

Table 3.1 – Efflux parameters that must be specified for each efflux type.

3.2.3 Source geometry

Recall that the source height (Zs) has already been defined in Section 3.2.2 (list element 3). A point source is a release at the specified height, located at (**X**,**Y**). It is assumed to be horizontal and circular in cross-section, with diameter as specified by the user.

3.2.4 Source emissions

To enter emissions data for the source, select **Sources** on the **Source** screen, then click on the **Emissions...** button. The **Emissions** screen is then displayed (see **Figure 3.5)**. Up to 80 pollutants may be emitted by each source; these emissions are defined using the **New** and **Delete** buttons. Properties of pollutants are defined in ADMS-Screen by means of the **Palette of Pollutants** screen, which is accessed by selecting **Pollutants...** from the **Emissions** screen or the **Data...** button in the **Palette** section of the **Setup** screen.

---

*Note that successive clicks on the **New** button will cause pollutants to be added to the list for this source in the order they appear in the **Palette of Pollutants**.*

The units used to define the emission rate are in g/s.

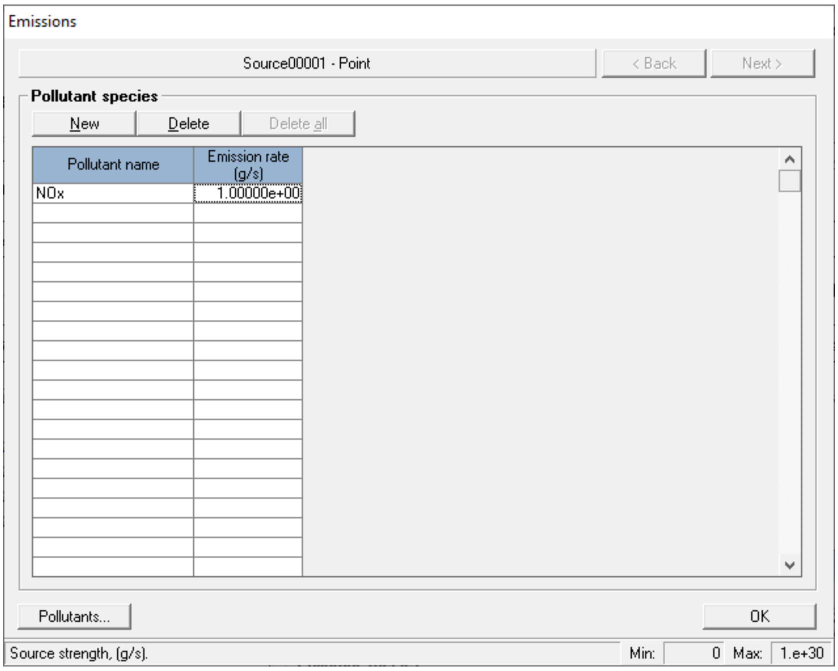


Figure 3.5 – **Emissions** screen for specifying pollutant emission rates.

3.3 Meteorology screen

The **Meteorology** screen shown in **Figure 3.6** allows details about the site and the meteorological conditions to be entered.

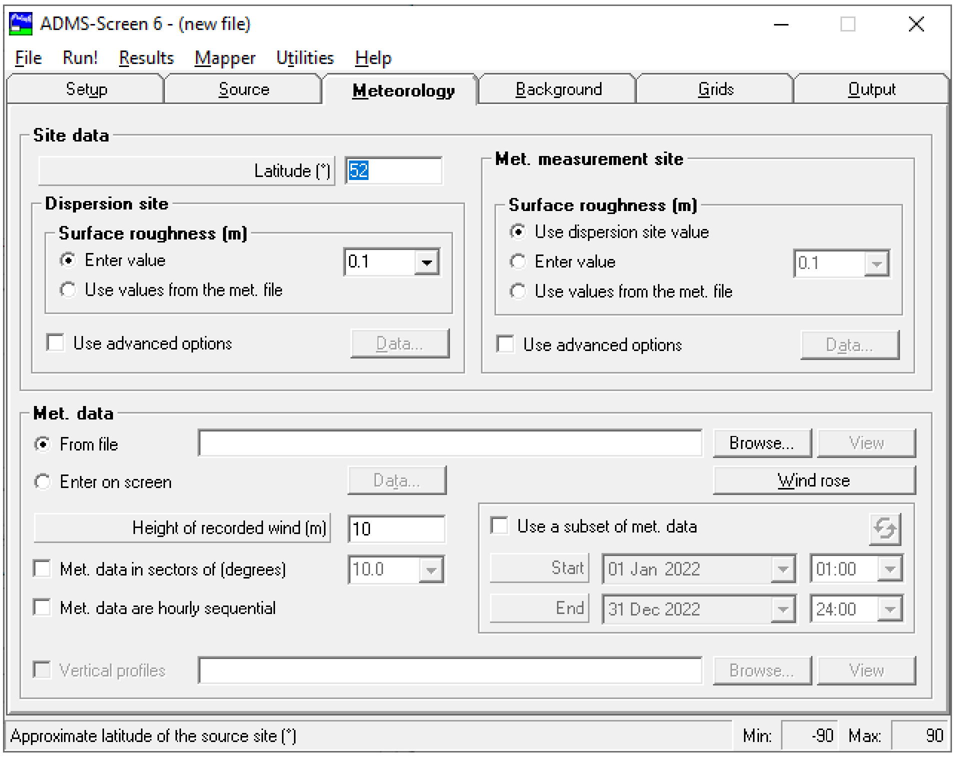


Figure 3.6 – The **Meteorology** screen in the ADMS-Screen interface.

There are two main boxes on the screen: the **Site data** box for entering details about the dispersion and meteorological measurement sites, and the **Met. data** box for entering details of the meteorological data.

The meteorological data can either be entered on screen or through a prepared meteorological data file. This file may be an example file supplied in the *<install path>\Data* directory, a file prepared by the user from their own available data (for example from an on-site meteorological station) or a pre-formatted file obtained from a supplier.

There are three different types of meteorological data that can be entered:

- a series of unrelated meteorological conditions,
- a series of hourly sequential data covering a certain period, for instance a year,
- statistical data covering a series of years (this can only be entered using a file).

Examples of each of these can be found in the *<install path>\Data* directory. Some of the files in this directory such as *oneday.met* and *stat.met* are for use in the worked examples and do not contain meaningful data to be used in actual calculations.

There is a minimum amount of data that must be entered. These are the wind speed (`U`) and wind direction (`PHI`) and either

- The Julian day number, time of day (local solar time) and cloud cover (`TDAY`, `THOUR` and `CL`),

or

- Sensible surface heat flux (`FTHETA0`),

or

- Reciprocal of Monin-Obukhov length (`RECIPLMO`).

Additional meteorological parameters can be added to the meteorological data file, and should be included if known. Full details of the parameters that can be included can be found in Section 9.

3.3.1 Site data

The **Site data** box allows for the details about both the dispersion and meteorological sites to be entered. The **Latitude** of the site must be entered by the user and must lie between -90° and 90°. The default is 52°, which is appropriate for southern to mid-England and for South Wales.

On other screens Cartesian coordinates of sources and receptors are required. It is assumed that the positive X and Y axes point east and north, respectively.

In the **Dispersion site** box, enter the **Surface roughness** at the dispersion site (in metres) based on land use. Either enter a value directly in the **Enter value** box, subject to the model limits (minimum = 10^{-7} m, maximum = 10 m), or alternatively use the drop-down box to select a value based on the land use − **Table 3.2** shows the land use types and corresponding values of surface roughness. The default value of surface roughness is 0.1 m, corresponding to a region of root crops. To enter hourly varying surface roughness values for the dispersion site via the meteorological data file, select the **Use values from the met. file** option and add the surface roughness values to the file using the variable name '`Z0 (D)`'.

Land use	Surface roughness (m)
Large urban areas	1.5
Cities, woodlands	1
Parkland, open suburbia	0.5
Agricultural areas (max)	0.3
Agricultural areas (min)	0.2
Root crops	0.1
Open grassland	0.02
Short grass	0.005
Sea	0.0001

Table 3.2 − The surface roughness values for the different land uses available on the **Meteorology** screen.

The surface roughness length selected for the dispersion site is assumed to apply throughout the domain. The **Met. measurement site** box allows surface roughness and other characteristics of the meteorological measurement site to be entered, if they are different from those at the dispersion site. To enter hourly varying surface roughness values for the meteorological site via the meteorological data file, select the **Use values from the met. file** option, and add surface roughness values to the meteorological data file using the variable name '`Z0 (M)`'.

For both the dispersion site and met. measurement site, **Use advanced options** can be selected to allow the user to alter the values of surface albedo, Priestley-Taylor parameter, minimum Monin-Obukhov length and precipitation differences between the dispersion site and meteorological measurement site. Details of how to use these options are given in Section 4.2.

3.3.2 Met. data

The **Met. data** box allows the data entry method for the meteorological data to be selected and other details about the meteorological data to be entered. The options available are as follows.

- **From file**: meteorological data are to be read from a file (the name of the file should be entered by the user). Clicking **Browse...** displays the directory structure and lets the user select prepared meteorological data files, which, by convention, have the extension *.met*. The **View** button allows the current *.met* file to be viewed. Further information on entering meteorological data using a *.met* file can be found in Sections 3.3.3 and 9.1.
- **Enter on screen**: meteorological data are to be entered on screen. Click on the **Data...** button to enter the data; full details of this option can be found in Section 3.3.4.
- **Wind rose**: shows the wind rose for the meteorological data file selected.
- **Height of recorded wind (m)**: height of the wind measurements (default = 10 m). A value of 0 m indicates the wind is a friction velocity measurement and a value of 1000 m indicates it is the geostrophic wind.
- **Met. data in sectors of (degrees)**: if the wind measurements are in sectors, check the box and enter the sector size, either by selecting one of the options from the drop-down list or directly into the box (refer to Section 9.1 for further details).
- **Met. data are hourly sequential**: check the box if the meteorological data are hourly sequential or are to be interpolated to become hourly sequential (refer to Section 9.1). If a series of unrelated meteorological data are entered, for instance to examine what happens during specific meteorological conditions, this box should not be checked.
- **Use a subset of met. data**: check this box to only use a subset of the meteorological data; the date and times of the first and last met. lines should be entered. The start and end dates can be automatically set to those of the meteorological data file by clicking the reset button, . Additionally, right-click options exist that allow you to quickly set the **Start** date and time to the start of the met. file or match the subset **End** date and time, and to set the **End** date and time to the end of met. file or match the subset **Start** date and time.
- **Vertical profiles**: not available in ADMS-Screen

3.3.3 Entering meteorological data from a file

If the meteorological data are to be entered from a file, then on the **Meteorology** screen first select **From file**, then click on **Browse…** and search to find the file. The selected file can then be viewed using the **View** button. Meteorological data files are comma-separated files with a *.met* extension, by convention. The format of the meteorological data file should be as follows.

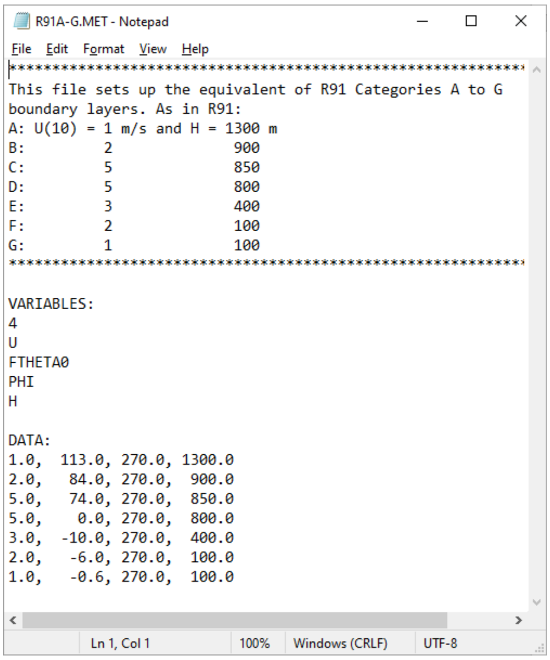
The first line should contain the keyword "`VARIABLES:`". The second line should contain the number of parameters to be entered in the *.met* file. Then follows a list of the parameters by name (one per line) for which data are entered in the *.met* file (details of the names to be used for each parameter can be found in Section 9.1). The data section starts with the keyword "`DATA:`" followed by the actual data. For each line of meteorological data, the parameters should be entered in a row in the order that they are listed in the "`VARIABLES:`" section. Comments can be added before the "`VARIABLES:`" and between the "`VARIABLES:`" and "`DATA:`" sections, no blank lines should appear in the file except as part of the comments. Further details about the format of the *.met* file can also be found by looking at *METDEMO.met* which can be found in the *<install path>\Data* directory.

Any missing data should be identified using the value '-999'.

There are various different ways of using a *.met* file, details of each of these are given below.

Using one of the prepared example files

There are a number of example *.met* files provided with ADMS-Screen. They are installed in the *<install_path>\Data* directory of your computer. A particularly useful file is *R91A-G.met*, which contains seven lines of meteorological data that correspond approximately to stability classes A-G. This file can be viewed in an editor such as Notepad or WordPad and is shown in **Figure 3.7**.



```
R91A-G.MET - Notepad
File Edit Format View Help
*********************************************************
This file sets up the equivalent of R91 Categories A to G
boundary layers. As in R91:
A: U(10) = 1 m/s and H = 1300 m
B:         2              900
C:         5              850
D:         5              800
E:         3              400
F:         2              100
G:         1              100
*********************************************************

VARIABLES:
4
U
FTHETA0
PHI
H

DATA:
1.0,  113.0, 270.0, 1300.0
2.0,   84.0, 270.0,  900.0
5.0,   74.0, 270.0,  850.0
5.0,    0.0, 270.0,  800.0
3.0,  -10.0, 270.0,  400.0
2.0,   -6.0, 270.0,  100.0
1.0,   -0.6, 270.0,  100.0

Ln 1, Col 1    100%    Windows (CRLF)    UTF-8
```

Figure 3.7 − The *.met* file *R91A-G.met*.

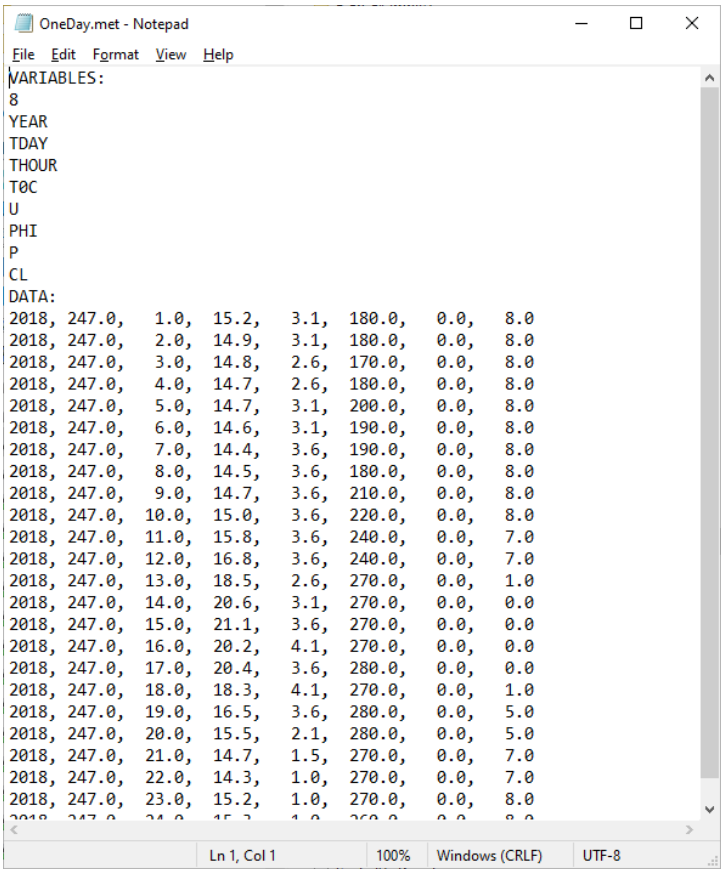
This file can be used as it is, or edited, for instance by changing the wind direction (`PHI`) to investigate the effect of different wind directions on the concentration distribution around a building or in complex terrain. For a list of the variable names and their meanings, refer to Section 9.1 of this user guide. When using a file like this that represents a set of unrelated meteorological conditions, the **Met. data are hourly sequential** box should not be checked.

It is good practice to use this file in a preliminary model run to obtain a quick indication of what the maximum concentration from a source will be, the location of the maximum concentration, and under which type of meteorological condition it occurs. This enables the user to obtain an early indication of likely results and, in particular, aids in setting up an appropriate calculation grid before running a long-term average calculation.

Hourly sequential meteorological data

Hourly sequential data can either be entered using files prepared by the user, say from an on-site meteorological station or using files obtained from a supplier. Hourly sequential files are normally available for periods of one year. Each line of data represents one hour of measurements, and therefore a data file for one (non-leap) year contains 8760 lines of data. This is the type of data used for modelling historical pollution episodes where the actual hour-by-hour meteorological conditions during the episode are modelled. It can also be used to calculate peak hourly average concentrations and long-term average concentrations.

Alternatively, meteorological data which are not hourly sequential, but are in chronological order, can be input into ADMS-Screen. These data will then be interpolated to become hourly sequential, providing certain criteria regarding the variables used in the meteorological files are met. Please refer to Section 3.3.5 for more details.


OneDay.met - Notepad

File Edit Format View Help

```
VARIABLES:
8
YEAR
TDAY
THOUR
T0C
U
PHI
P
CL
DATA:
2018, 247.0,  1.0, 15.2,  3.1, 180.0,  0.0,  8.0
2018, 247.0,  2.0, 14.9,  3.1, 180.0,  0.0,  8.0
2018, 247.0,  3.0, 14.8,  2.6, 170.0,  0.0,  8.0
2018, 247.0,  4.0, 14.7,  2.6, 180.0,  0.0,  8.0
2018, 247.0,  5.0, 14.7,  3.1, 200.0,  0.0,  8.0
2018, 247.0,  6.0, 14.6,  3.1, 190.0,  0.0,  8.0
2018, 247.0,  7.0, 14.4,  3.6, 190.0,  0.0,  8.0
2018, 247.0,  8.0, 14.5,  3.6, 180.0,  0.0,  8.0
2018, 247.0,  9.0, 14.7,  3.6, 210.0,  0.0,  8.0
2018, 247.0, 10.0, 15.0,  3.6, 220.0,  0.0,  8.0
2018, 247.0, 11.0, 15.8,  3.6, 240.0,  0.0,  7.0
2018, 247.0, 12.0, 16.8,  3.6, 240.0,  0.0,  7.0
2018, 247.0, 13.0, 18.5,  2.6, 270.0,  0.0,  1.0
2018, 247.0, 14.0, 20.6,  3.1, 270.0,  0.0,  0.0
2018, 247.0, 15.0, 21.1,  3.6, 270.0,  0.0,  0.0
2018, 247.0, 16.0, 20.2,  4.1, 270.0,  0.0,  0.0
2018, 247.0, 17.0, 20.4,  3.6, 280.0,  0.0,  0.0
2018, 247.0, 18.0, 18.3,  4.1, 270.0,  0.0,  1.0
2018, 247.0, 19.0, 16.5,  3.6, 280.0,  0.0,  5.0
2018, 247.0, 20.0, 15.5,  2.1, 280.0,  0.0,  5.0
2018, 247.0, 21.0, 14.7,  1.5, 270.0,  0.0,  7.0
2018, 247.0, 22.0, 14.3,  1.0, 270.0,  0.0,  7.0
2018, 247.0, 23.0, 15.2,  1.0, 270.0,  0.0,  8.0
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

Figure 3.8 − Example of hourly sequential meteorological data file.

An example of the beginning of an hourly sequential file is shown in **Figure 3.8**. If this type of file is being used then the **Met. data are hourly sequential** box should be checked on the **Meteorology** screen. Wind direction measurements (`PHI`) are often reported to the nearest 10 degrees, i.e. the wind data are in 10 degree sectors. If this is the case, the **Met. data in sectors of (degrees)** option should be selected and the sector size entered.

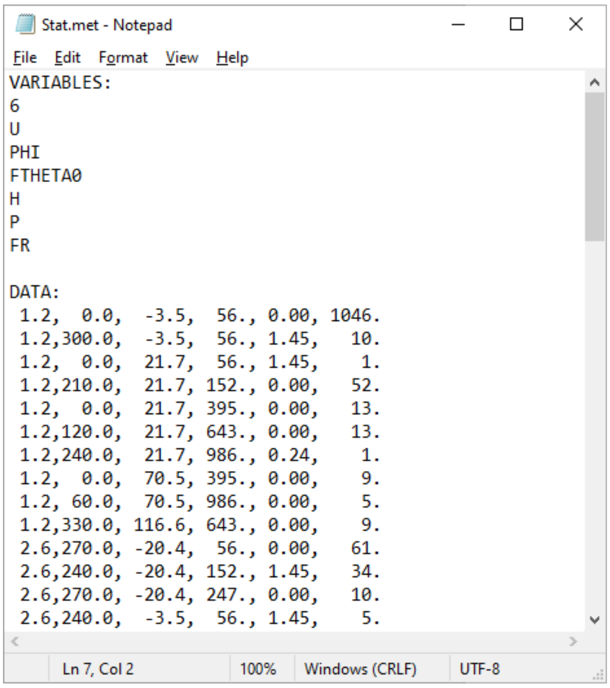
Hourly sequential files can be used for long-term average concentration and percentile calculations for comparison with regulatory standards. Since sequential data files consist of continuous hour-by-hour measurements, they are a better representation of actual meteorological conditions than statistically-averaged data files.

However, it is important to note that year-to-year variations occur in meteorological conditions. Therefore, any conditions resulting in very high ground level concentrations one year would not necessarily have occurred in the previous year nor would they necessarily occur the following year. High percentiles of concentration will therefore vary according to the year of meteorological data used. Annual averages are less sensitive to the choice of year.

Up to ten years' worth of data may be included in a sequential data file.

Statistical meteorological data

Statistical data files normally include meteorological data for a period of ten years. They can be obtained from a supplier, e.g. the UK Met Office. They can be viewed in a text editor, and an example showing the beginning of a statistical file is given in **Figure 3.9**.




```
VARIABLES:
6
U
PHI
FTHETA0
H
P
FR

DATA:
 1.2,  0.0,  -3.5,  56., 0.00, 1046.
 1.2,300.0,  -3.5,  56., 1.45,   10.
 1.2,  0.0,  21.7,  56., 1.45,    1.
 1.2,210.0,  21.7, 152., 0.00,   52.
 1.2,  0.0,  21.7, 395., 0.00,   13.
 1.2,120.0,  21.7, 643., 0.00,   13.
 1.2,240.0,  21.7, 986., 0.24,    1.
 1.2,  0.0,  70.5, 395., 0.00,    9.
 1.2, 60.0,  70.5, 986., 0.00,    5.
 1.2,330.0, 116.6, 643., 0.00,    9.
 2.6,270.0, -20.4,  56., 0.00,   61.
 2.6,240.0, -20.4, 152., 1.45,   34.
 2.6,270.0, -20.4, 247., 0.00,   10.
 2.6,240.0,  -3.5,  56., 1.45,    5.
```

Figure 3.9 − Example of statistical meteorological data file.

The aim of using statistically analysed data is to take account of the variation in meteorological conditions from year to year. Each hourly measurement for that period is recorded and put into a bin or class representing a range of different values for different meteorological parameters. For example, in the file represented in **Figure 3.9**, the data were categorized into five classes of wind speed (`U`), twelve classes of wind direction (`PHI`) (i.e. a wind sector size of 30 degrees), six classes of surface sensible heat flux (`FTHETA0`), seven classes of boundary layer depth (`H`), and three classes of precipitation (`P`).

There are typically over 2000 lines of data in a statistical meteorological data file, each line corresponding to a particular combination of meteorological conditions that occurred, for example the first line corresponds to the first class or bin of each of the five parameters. Each line has an associated frequency representing the number of hours that occurred during the period of the data (usually ten years) with meteorological conditions within the ranges described by that line of data.

Users should ensure they read any information at the beginning of a statistical meteorological data file, in particular the 'Effective height of anemometer above ground'. For the majority of files it is 10 m but occasionally it is at some other height and the correct value should be entered into the ***Meteorology*** *screen of ADMS-Screen.*

Statistical data has a number of advantages over sequential data.

- There are typically about 2000 lines of data to process in ADMS-Screen with a statistical meteorological data file rather than 8760 in a one year sequential file; run times are therefore significantly shorter for statistical than sequential data.
- Statistical data is representative of the meteorological conditions which occurred over several years (usually ten); year-to-year variations in conditions are therefore accounted for. This is not true for sequential data.

A disadvantage of using statistical meteorological data is that because the data are categorised into bins with pre-defined upper and lower bounds, it is the mean for each bin rather than the actual hourly value of a parameter that is processed by ADMS-Screen. Thus extreme conditions are smoothed out. For example, there may be a few hours in a particular year when the surface heat flux is extremely high thus generating a lot of convective mixing and bringing an elevated plume down to the ground very quickly. This would normally result in high maximum ground-level concentrations near the source. Using sequential data, the data file would contain the actual high surface heat flux value for that particular hour, thus representing actual conditions. Using statistical data, the value of surface heat flux used would be the mean value of the appropriate class. In this case, this mean value would be less than the true hourly value and would thus underestimate the amount of convective turbulence hence underestimating ground level concentrations for that hour.

In general, high percentiles obtained with sequential data are larger than those obtained with statistical data. Sequential data must be used when using background data from files. Sequential data are also required for generating results for comparison with regulatory standards defined in terms of rolling or running means as statistical data are inappropriate for such calculations.

3.3.4 Entering meteorological data on screen

If the meteorological data are to be entered on screen, first select the **Enter on screen** option on the **Meteorology** screen, then click on the **Data...** button. This will bring up the **Meteorological Data** screen shown in **Figure 3.10**.

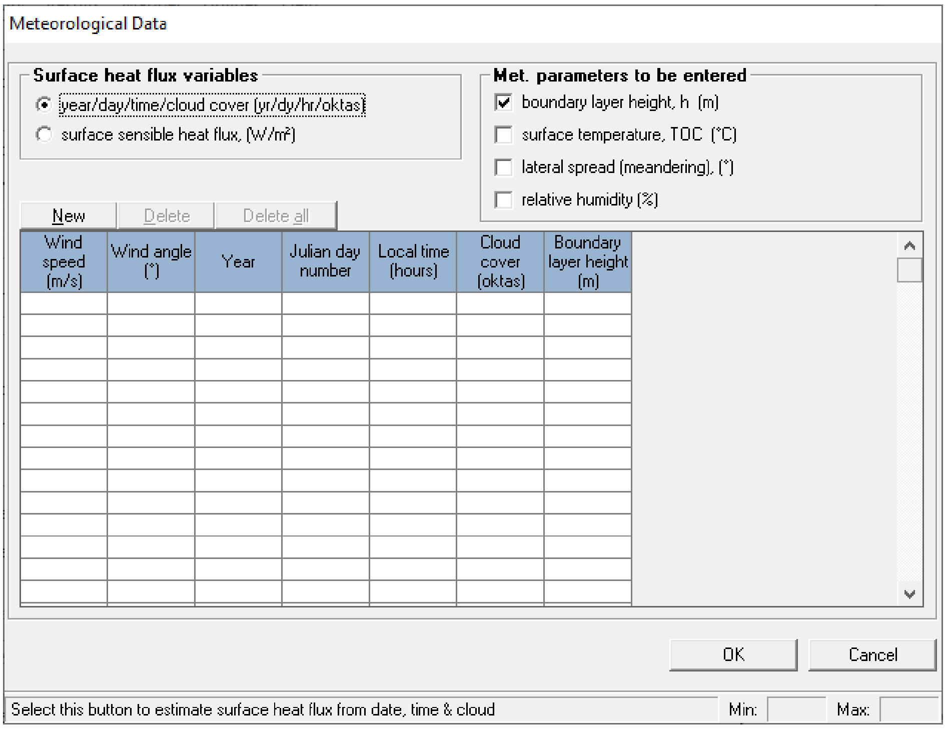


Figure 3.10 – The **Meteorological Data** screen used for entering meteorological data on screen.

This screen contains the table of data to be specified. The table always contains columns for wind speed and wind angle. It also includes surface heat flux variables. The user *must* select one of the two options in the **Surface heat flux variables** box: either **year/day/time/cloud cover (yr/dy/hr/oktas)** or **surface sensible heat flux, (W/m²)**.

The choice of option determines the number of columns in the table.

In addition, data *may* be entered for one or more of the four options in the **Met parameters to be entered** box if the user has accurate information. These are the **boundary layer height, h (m)**, the **surface temperature, TOC (°C)**, the **lateral spread (meandering), (°)** and the **relative humidity (%)**. Clicking in the check box beside each variable name causes the corresponding column to appear or disappear, as appropriate.

Click on the **New** button to add default lines of data, which may then be edited by the user, or click the **Delete** button to remove the selected line of data from the table.

It is not possible to enter more than 99 lines of meteorological data by hand.

The columns of data are as follows:

- **Wind speed (m/s)**: wind speed at the measurement height.

  Minimum = 0 m/s
  Maximum = 100 m/s
  Default = 5 m/s

- **Wind angle (°)**: direction of the wind measured clockwise from north (e.g. 270° for a wind coming from the west)

Minimum = 0°
Maximum = 360°
Default = 270°

- **Year**: year

  Minimum = 1900
  Maximum = 2100
  Default = Current year

- **Julian day number**: Julian day, e.g. Jan 1st = 1, Dec 31st = 365 or 366

  Minimum = 1
  Maximum = 366
  Default = 1

- **Local time (hours)**: time e.g. for hour ending at 4pm (16:00) hours enter 16

  Minimum = 0
  Maximum = 24
  Default = 12 (then increments by 1 hr with further clicks of the **New** button)

- **Cloud cover (oktas)**: cloud cover

  Minimum = 0
  Maximum = 8
  Default = 0

- **Surface sensible heat flux (W/m²)**: surface sensible heat flux

  Minimum = -200 W/m^2
  Maximum = 1 000 W/m^2
  Default = 0 W/m^2

- **Boundary layer height (m)**: height of the boundary layer

  Minimum = 40 m
  Maximum = 3 000 m
  Default = 800 m

- **Surface temp (°C)**: surface temperature

  Minimum = -100°C
  Maximum = 60°C
  Default = 15°C

- **Lateral spread (°)**: standard deviation of mean wind direction

  Minimum = 0°
  Maximum = 90°
  Default = 7.5°

- **Relative humidity (%)**: relative humidity

  Minimum = 0%
  Maximum = 100%

Default = 50%

The user should refer to Section 9.1 for more detailed information on the parameters appearing on the **Meteorology** screen.

3.3.5 Interpolation of meteorological data

In order to model averaging times greater than one hour, hourly sequential meteorological data are required. If hourly sequential data are not available, but a chronological sequence of meteorological data are available then, providing certain constraints are met, the data will be interpolated to become hourly sequential. To enable this option enter your meteorological data as described in sections 3.3.3 or 3.3.4 and check the **Met. Data are hourly sequential** box.

In order for the meteorological data to be interpolated, they must meet the following criteria:

- Contain year, day and hour;
- Be in chronological order, with gaps no larger than 9 hours;
- Contain wind speed, wind direction and cloud cover; and
- Not contain any variables that cannot be interpolated – please refer to Section 9.1 for details.

---

*If the meteorological data entered are hourly sequential and the **Met. Data are hourly sequential** box is checked, no interpolation will be carried out and the restrictions regarding which variables can be entered do not apply.*

If the chronological sequence of meteorological data entered can be interpolated by the model to a series of hourly sequential data covering the same period, the interpolated meteorological data will then be modelled.

3.4 Background screen

The **Background** screen shown in **Figure 3.11** allows the user to enter background data for any of the pollutants entered in the **Palette of Pollutants**.

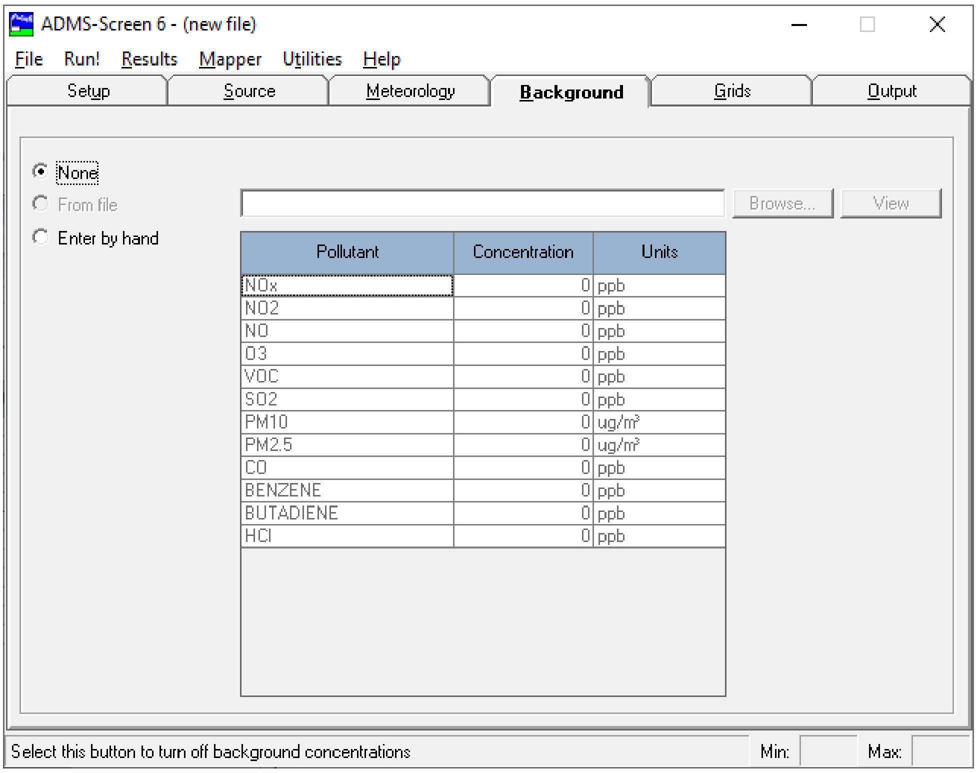


Figure 3.11 – The **Background** screen.

When predicting pollutant contributions it can be important to take into account the underlying, or background, levels of pollutants in the atmosphere.

Care should be taken that the appropriate background data are selected for each modelling scenario. If all of the local major sources of pollution are included in the model run, for instance an isolated industrial source, then background from a rural site outside (and ideally upwind of) the modelling domain should be chosen, to avoid double-counting the effect of the modelled source. On the other hand, if not all of the local sources of pollution are to be modelled, for instance an industrial complex in an urban area, then background concentration values taking into account those sources which are not being modelled should be used, although again care should be taken not to double-count any source which is being modelled.

If background concentrations are permitted, then the **Background** screen presents three options:

- **None**: no background concentrations.
- **From file**: not available in ADMS-Screen
- **Enter by hand**: constant background values entered directly on screen (refer to Section 3.4.1 for more details).

3.4.1 Entering background data by hand

To enter constant values of background data directly on screen, first select the **Enter by hand** option. The table contains all of the pollutants in the **Palette of Pollutants** and their background values, along with the units of these background values. The following should be noted:

- The background value and units of NO cannot be edited; instead the value is calculated from the background values of NO_X and NO_2 that have been entered.
- Background concentrations of particulate pollutants can only be specified in mass units.

3.5 Grids screen

The **Grids** screen shown in **Figure 3.12** allows the user to define output points at which concentration values will be output by the model. Output points may be defined as a grid (**Gridded output points**), individually (**Specified points**) or both. Grids of output points may be defined with regular or variable spacing.

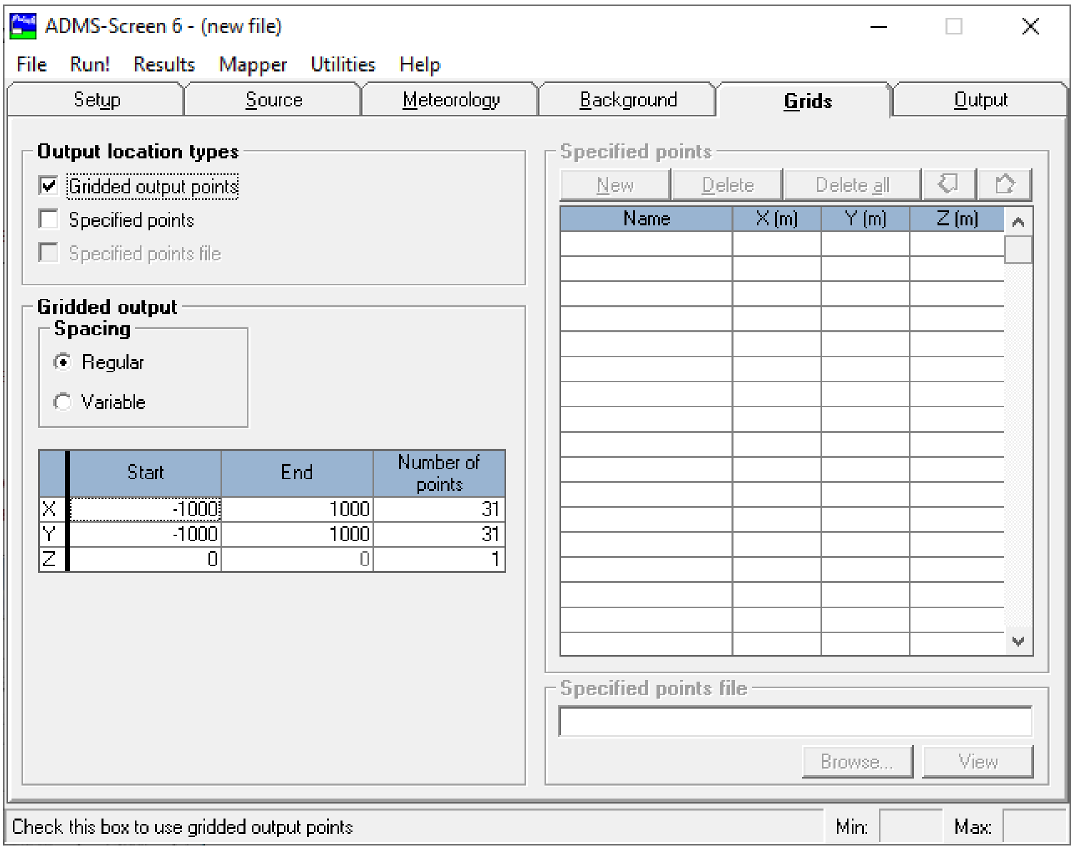


Figure 3.12 – The **Grids** screen for selecting an output grid and/or specified output points.

The units of output points are metres and they may be defined anywhere in 3D space, but must be on or above the ground and are subject to the following restrictions:

- Horizontal coordinates (**X** and **Y**):

  Minimum: -10^7 m

  Maximum: 10^7 m

- Vertical coordinate (**Z**):

  Minimum: 0 m

  Maximum: 15 000 m

3.5.1 Gridded output

With the **Gridded output points** option, there is some flexibility about the spacing between the individual receptor points. Grids may have Regular spacing, or Variable spacing.

Regular spacing

Regular Cartesian grids are specified by the **Start** and **End** X, Y and Z coordinates, representing the minimum and maximum values in each direction, together with the **Number of points** along the X, Y and Z axes. The maximum resolution in each of the X and Y directions is 51 points, only one Z level can be modelled. The grid spacing is automatically calculated once the number of points in each direction has been set.

Variable spacing

Variable Cartesian grids are specified by X, Y and Z coordinates entered in the **X**, **Y** and **Z** boxes as shown in **Figure 3.13**. To enter **X**, **Y** and **Z** values, click in the small text box in that column, type the value then press the **SPACE** bar. To remove points, select them in the larger, upper text box, and press the **DELETE** key. Results will be calculated on a grid of points at the specified **X**, **Y** and **Z** values. For example, if three **X** values, four **Y** values and one **Z** value are specified, results will be calculated on a grid of 12 points.

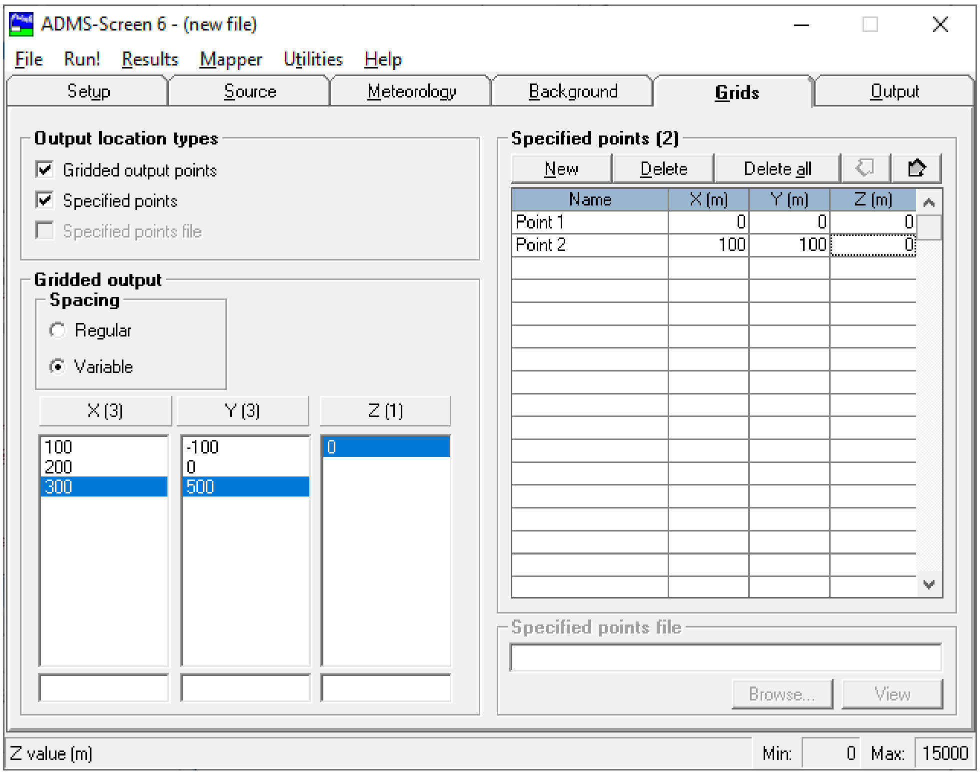


Figure 3.13 – The **Grids** screen when a variable Cartesian grid is specified. The numbers in brackets in the column headers indicate the number of points in each column box.

3.5.2 Specified points

Specified points may be added to or deleted from the table on the right-hand side of the **Grids** screen by clicking on the **New** and **Delete** buttons, respectively, if the **Specified**

points option is selected in the **Output location types** box. The maximum number of points is 100. Points may be given a name by the user (e.g. "point 1", "School") and have to be specified with **X, Y** and **Z** coordinates. The names given to the specified points must not contain commas and must contain no more than 30 characters.

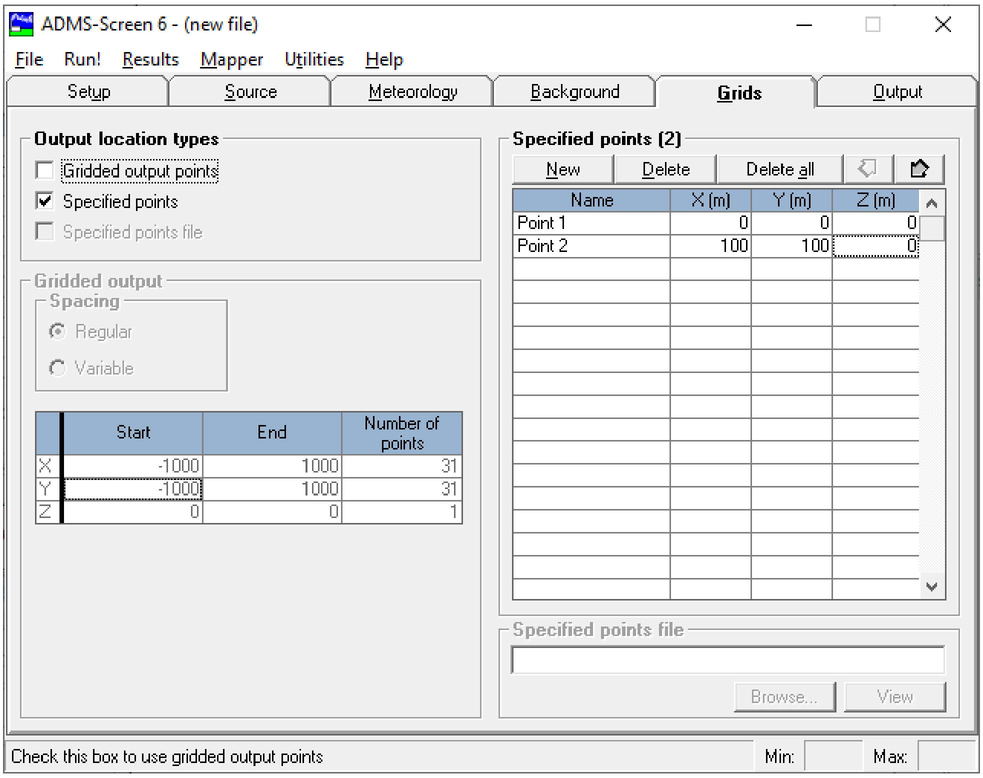


Figure 3.14 – The **Grids** screen showing specified points entered via the interface.

3.6 Output screen

The pollutants and sources for which output is to be calculated, together with the type of output required, are selected in the **Output** screen, shown in **Figure 3.15**.

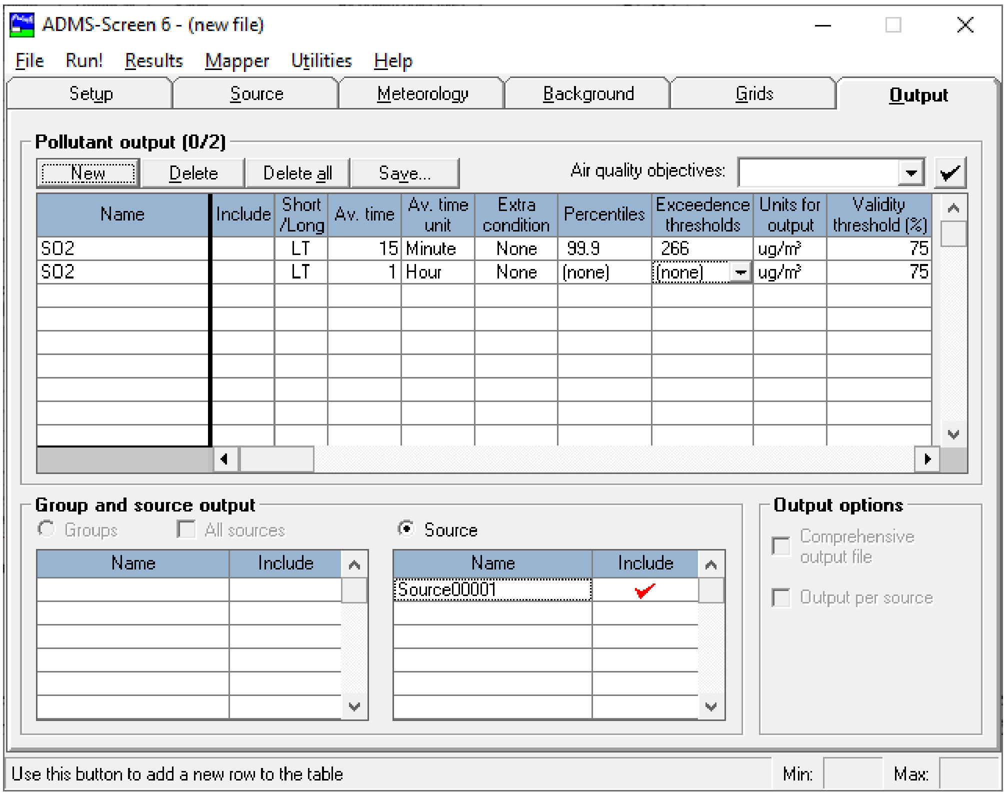


Figure 3.15 – The **Output** screen shown for the case of a short-term calculation for a single source.

3.6.1 Pollutant output

Pollutants may be added to or deleted from the upper table by clicking on the **New** and **Delete** buttons. For each pollutant, parameters to be specified are described below. The user **must** select the pollutant name (1), indicate whether the pollutant will be included in the output (2), whether short- or long-term calculations are required (3), and select the averaging time (4), the output units (8) and the met. data validity threshold (9). The other parameters (5, 6, 7) are optional.

1. **Name**

   From the drop-down list, the name of the pollutants for which concentrations are to be calculated can be selected. The list contains all pollutants from the **Palette of Pollutants**.

   Default = **NOx**

The same pollutant name may be entered twice in the table in order to calculate, for example, short-term statistics for one entry and long-term statistics for the other entry.

---

2. **Include**

   A tick must be present in this column for the model to calculate output for the corresponding pollutant. Click in the box to toggle between tick or no tick, or type **Y** in the box to add a tick or **N** to remove it.

   Default = included

   Right-clicking within the ***Include*** *column will open a menu allowing for the manipulation of the inclusion status for all outputs.*

3. **Short/Long**

   For each output pollutant, the type of average (short-term or long-term) to be calculated must be specified. Click in this cell to toggle between **ST** (short-term) and **LT** (long-term). Following these first three columns, various other options are available in the rest of the table depending on whether **ST** or **LT** is selected, as illustrated in **Figure 3.15**.

   If short-term averages are selected, then any gridded concentration output files (e.g. *filename.gst*) will contain output for the first 24 lines of meteorological data only. If specified point output is selected, the file *filename.pst* will contain a set of concentrations for every line of meteorological data.

   If long-term averages are selected, then the concentration output files (e.g. *filename.glt* for gridded output and *filename.plt* for specified points) contain *a single set of concentration data*, averaged over all the lines of meteorological data.

   Default = **ST**

4. **Av. time (Value, Unit)**

   Select the appropriate averaging time over which concentrations should be averaged for each pollutant. Note that ADMS-Screen allows the user to select different averaging times for different pollutants or the same pollutant *in the same run* (e.g. 15 minutes for SO_2 and 1 hour for NO_X). A drop-down list presents commonly-used averaging times, and may be accessed by clicking on the **Av. time** cell and then pressing the **ALT** and ↓ keys.

   See Appendix C for the averaging times relevant to air quality guidelines (e.g. NAQS objectives) and Section 3.6.2 for a convenient way to enter these.

   Minimum = 0 second
   Maximum = 1 week for hourly sequential met. data, 1 hour for statistical data
   Default = 1 hour

   It is ***compulsory*** *to have* ***Met. Data are hourly sequential*** *checked on the* ***Meteorology*** *screen in order to be able to select an averaging time greater than 1 hour.*

   For averaging times greater than 1 hour, rolling averages of concentration may be calculated. For example, for an averaging time of 8 hours for use in a long-term average over a 24 hour period, concentrations *without* rolling averages would be calculated for hours 1 to 8, 9 to 16 and 17 to 24 (i.e. 3 sets of calculations). However, if rolling averages are required, concentrations are calculated for hours 1 to 8, 2 to 9, 3 to 10, and so on. To enter a rolling average select **Hour rolling** in the **Av. time Unit** cell.

5. **Extra condition**

The options for an **Extra condition** are **None** and **Maximum daily**. If **None** is selected, no extra condition is applied. If **Maximum daily** is selected, then for short-term output, for each day, the maximum concentration (or deposition) value for the averaging periods which end on that day is output. For long-term output, the maximum concentration per day (based on the averaging periods which end on that day) is used in the percentiles and exeedence calculations.

Long-term average concentration values are always calculated using all averaging periods and not just the maximum for each day.

Default = **None**

6. **Percentiles** (long-term average only)

If long-term averages are being calculated, then up to 20 percentiles of concentration may be calculated for each pollutant. The N^{th} percentile is the concentration below which *N*% of the values fall. As an example, the 50th percentile of hourly average concentrations over a 24-hour period would be the 12th highest of the 24 one-hour averages (i.e. 50% of 24). In this case, the **Av. time** would be one hour and meteorological data for a period of one day would be used.

Different percentiles may be selected for different pollutants *in the same run* (e.g. 100th and 99.9th percentiles for SO_2 and 100th and 98th percentiles for NO_x). Worst case concentrations may be found by calculating the 100th percentile (i.e. the maximum concentration).

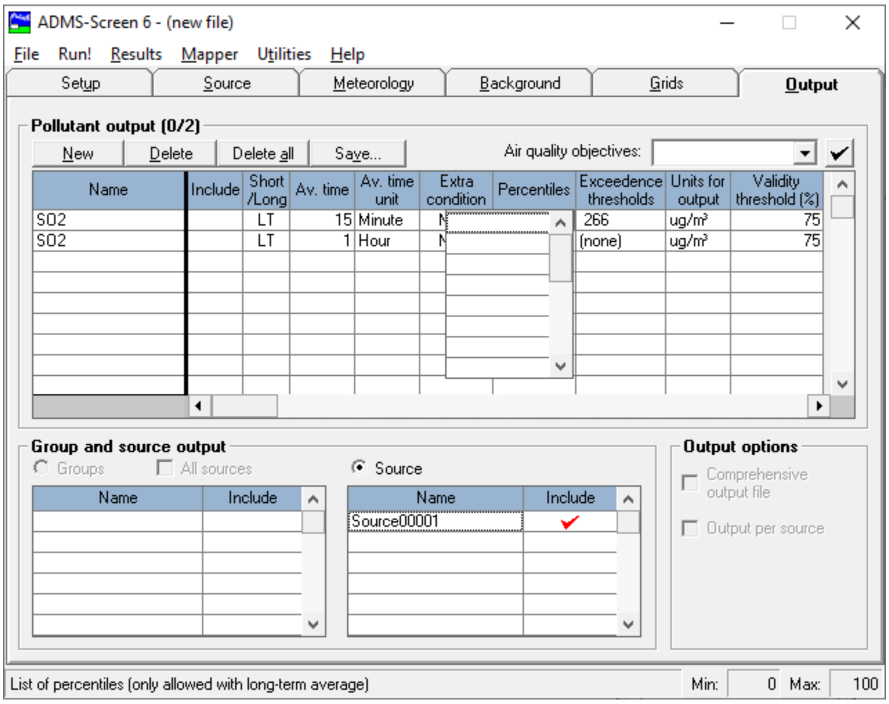


Figure 3.16 – Entering data into the **Percentiles** table.

Percentile values are entered via a table (as shown in **Figure 3.16**) which is made available when the drop-down arrow in the **Percentiles** value cell is clicked. Click on the first blank cell and type the desired percentile value. Pressing the down arrow moves to the next blank cell to allow further values to be entered, or pressing **Enter** exits the table, retaining the values already entered. Pressing the **Delete** key on a particular table entry deletes that particular percentile, whereas pressing the **Delete** key on the **Percentiles** cell when the table is minimised allows you to delete all percentiles from the table. The resulting list of percentiles will then be used for the given pollutant. Values are automatically sorted into descending order for convenience.

7. **Exceedences** (long-term average only)

   If long-term averages are being calculated, then up to 20 exceedence values may be entered. For each pollutant, the exceedence values are entered in the same units as displayed in the **Units for output** cell. The value of number of exceedences per annum will then be calculated by the model at each output point for each exceedence value entered. This is a useful way of looking at the results from the model because many air quality standards are stated in terms of number of exceedences per year (refer to Appendix C for more details).

   As for percentiles, different exceedence values may be entered for different pollutants. Exceedence values are entered and/or deleted via a table in the same way as for percentiles.

8. **Units for output**

   For each output pollutant, the units may be selected from the list available by clicking on this cell. The units available are:

ng/m^3	nanograms per cubic metre (1 ng = 10^{-9} g)
μg/m^3	micrograms per cubic metre (1 μg = 10^{-6} g)
mg/m^3	milligrams per cubic metre (1 mg = 10^{-3} g)
g/m^3	grams per cubic metre
ppb	parts per billion by volume
ppm	parts per million by volume

Default = μg/m^3

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ppb and ppm are not available as output units for particulate pollutants because they are only applicable to gases.

---

9. **Validity threshold (%)**

The value in this column states the percentage of met. lines in a given averaging period that need to be valid in order for that averaging period to be considered valid. For example, for an **Av. time** of 8 hours, if the validity threshold was set at 75%, you would need at least 6 met. lines to be valid in any given averaging period for that averaging period to be considered valid. Concentration values for any invalid averaging periods will be output as -999 in the (short-term) output files and not used in any subsequent calculations of maximum daily values (short-term and long-term), long-term averages, percentiles or exceedences (long-term). A maximum daily value is itself considered valid if there is at least the specified percentage of valid averaging periods within that day. If invalid, it will also be output as -999 in the (short-term) output files and not used in any subsequent calculations of percentiles or exceedences (long-term). Conversely, long-term averages, percentiles and exceedance values will always be given in the long-term output file as long as there is at least one valid averaging period from which to calculate these statistics; however a warning will be issued if less than the specified percentage of averaging periods were valid.

Minimum = 0 %
Maximum = 100 %
Default = 75 % (in line with various monitoring guidelines)

3.6.2 Air quality objectives

Many users are interested in comparing model results with air quality objectives. An option is available to facilitate this for some standard sets of objectives. Click on the **Air quality objectives** list on the **Output** screen, select a set of objectives and click the tick (see **Figure 3.17**). This action will populate the output table with the relevant air quality objective values (see **Figure 3.18**). When using this tool, the user is advised to check that the objectives are up-to-date.

---

*Using the **Air quality objectives** tool will delete all previous entries in the output table.*

A full list of the UK, EU, Lithuanian, French, US and WHO air quality objectives is given in Appendix C**.**

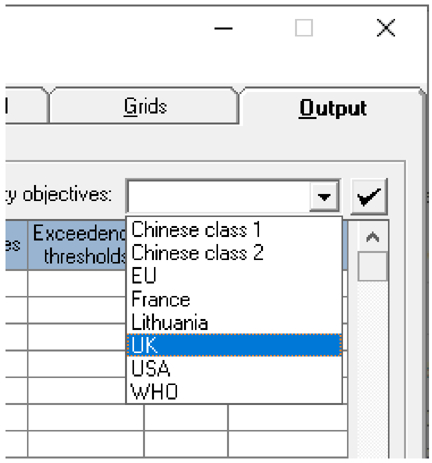


Figure 3.17 The **Air quality objectives** list with **UK** objectives selected

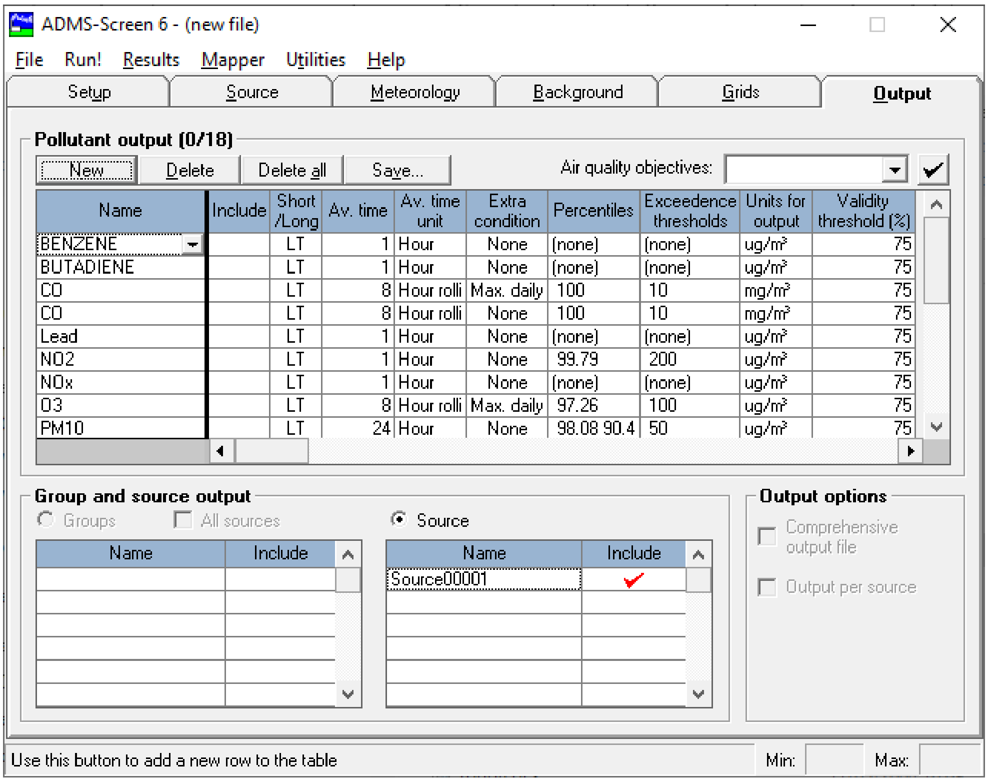


Figure 3.18 – The **Output** screen showing the effect of selecting **UK** from the **Air quality objectives** list and then clicking the tick.

---

*Pollutant output table entries added using the **Air quality objectives** tool are, by default, not included in the run. The user should put a tick in the **Include** column for those outputs required.*

Limitations

It is not possible to precisely define all the air quality objectives given in Appendix C using the **Pollutant output** table. Explanations for why some of the air quality objectives have not been defined exactly are given below:

- For air quality objectives defined in terms of a running annual mean, the calculated statistic in the **Pollutant output** table is defined as a long-term average.

Therefore, the calculated statistic will agree exactly with the objective if one year of meteorological data is used; more than one year of meteorological data cannot be modelled in ADMS-Screen.

- Air quality objectives defined as an average of a particular statistic over a number of years are specified in the **Pollutant output** table so that the results for one year will be calculated, if one year of meteorological data are used. In order to model a concentration that can be compared directly with the objective, several years of meteorological data should be run independently and the resulting values averaged.
- Air quality objectives based on 3-month, quarterly or seasonal averages are omitted from the **Pollutant output** table. Comparison to these objectives can be made by running each of the required meteorological periods separately, for instance, by using the meteorological subset option, and requesting a long-term average in each case.
- Air quality objectives based on AOT40 cannot be calculated directly from the model at present. If comparison to these objectives is required, it is recommended that concentrations for each hour are output by the model (by selecting short-term output) and that these concentration values are processed manually.

Saving air quality objective files

It is also possible to save your own set of **Air quality objectives**. Firstly, the required outputs should be entered into the **Pollutant output** table. Selecting **Save...** then brings up the **Save pollutant outputs to file** screen, as shown in **Figure 3.19**. In this screen enter:

- the **Caption**, to appear in the **Air quality objectives** list, and
- the **Description**, to appear in the helpline,

then click **OK**.

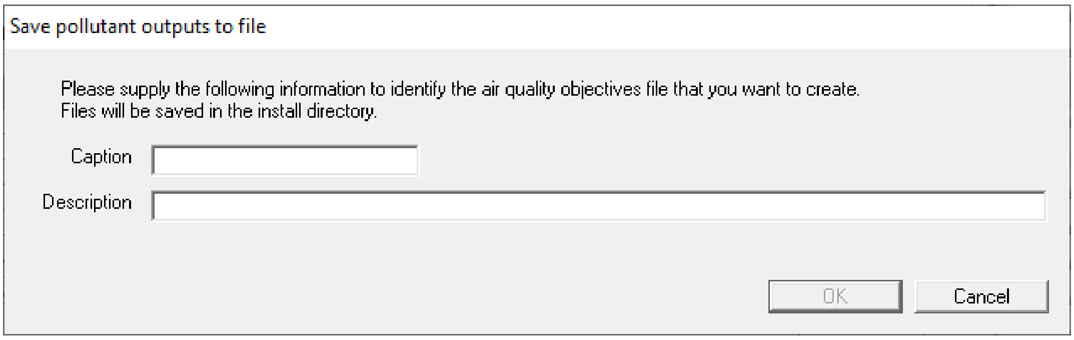


Figure 3.19 – The **Save pollutant outputs to file** screen.

3.6.3 Source output

For each model run, the user can calculate concentrations for a single source.

The **Source** option will automatically be selected above the lower right-hand table on the **Output** screen (see **Figure 3.15**). The table will show in the **Name** column the source available for the current model run. Click in the **Include** cell next to the source or enter

Y in that cell if no tick is shown next to the source. If an output grid is chosen the model will generate files containing model parameters on the plume centreline, e.g. σ_y, σ_z, that it may be useful to plot using the **Line Plot** utility (refer to Section 6.3 for further details).

Both **Output options** (**Comprehensive output file** and **Output per source**) are not available in ADMS-Screen and are therefore greyed out.

SECTION 4 Additional Model Options

This section describes additional model options available in ADMS-Screen.

Options such as deposition, radioactive decay, plume visibility, odours, chemistry, buildings, complex terrain, coastline, puffs, and fluctuations are listed in the **Model options** section of the **Setup** screen, as illustrated in **Figure 4.1**. However none of these options, with the exception of buildings, are available in ADMS-Screen.

Options related to the meteorological data are available in the **Meteorology** screen.

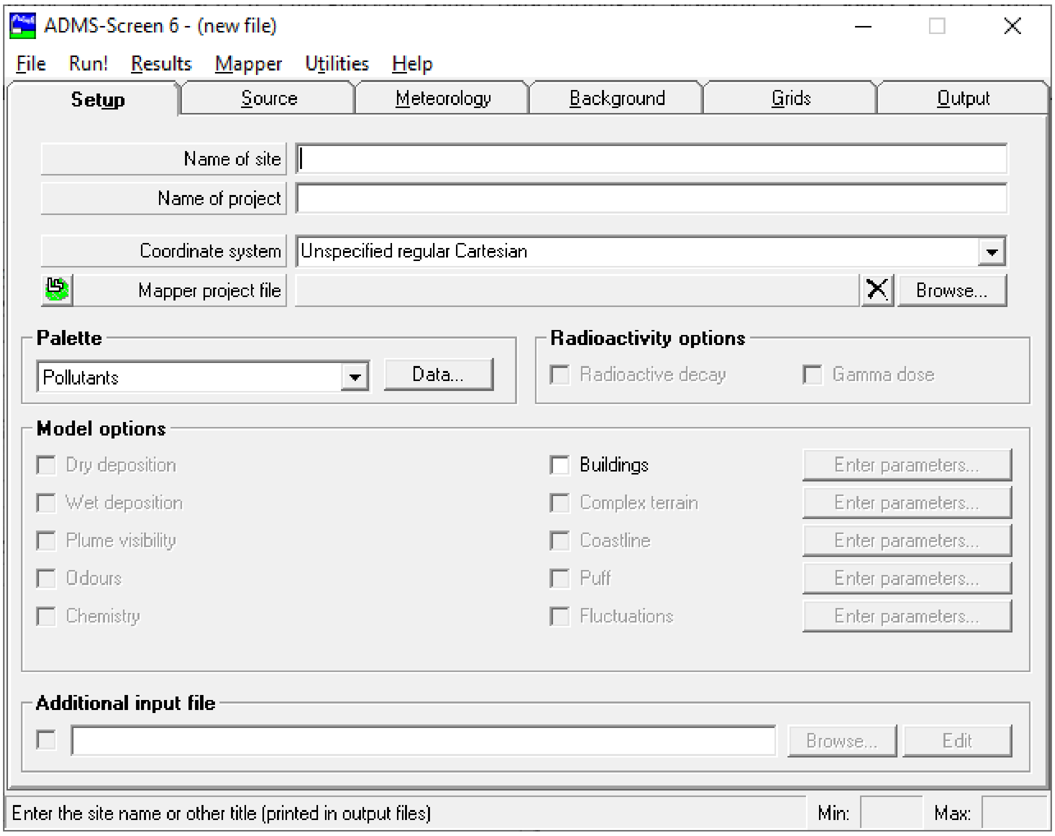


Figure 4.1 – The ADMS-Screen **Setup** screen.

4.1 Buildings

4.1.1 Building effects

Chimney stacks often protrude from the roof of a building or may be attached to the side of, or close to, a building.

Buildings can have a significant effect on the dispersion of pollutants from sources and can increase the maximum predicted ground level concentrations. The main effect of a building is to entrain pollutants into the cavity region in the immediate leeward side of the building, bringing them rapidly down to ground level. As a consequence, concentrations near the building are increased but further away concentrations are decreased.

The buildings module in ADMS-Screen allows the user to enter a single building in a run.

For the source, the program calculates an effective building for each data line in the meteorological file. This is described in more detail in Section 9.8.

4.1.2 Defining a building

Select the **Buildings** button on the **Setup** screen and click **Enter parameters...** to go to the **Buildings** screen shown in **Figure 4.2**.

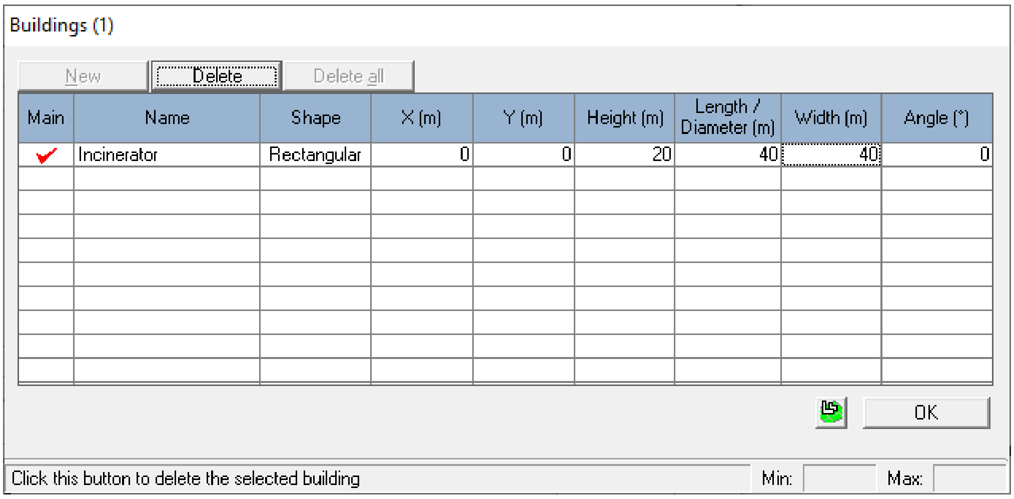


Figure 4.2 − The **Buildings** screen.

The user may add or remove a building in the table using the **New** and **Delete** buttons, respectively. The building is defined by the following parameters.

1. **Main**: As only one building may be entered in ADMS-Screen this is always defined as the main building.
2. **Name**: The model will use a default name when a new building is added (e.g. Building001). The user is advised to change this to something more meaningful

(e.g. boiler house). Building names must not contain commas and must contain no more than 30 characters.

3. **Shape**: shape of the building, either **Rectangular** or **Circular**. To change the shape of the building click on the cell.

   Default = **Rectangular**.

4. **X (m)**: X coordinate of the centre of the building
   Y (m): Y coordinate of the centre of the building

   Minimum = -9 999 999 m
   Maximum = 9 999 999 m
   Default = 0 m

The large maximum value allows the user to input UK National Grid coordinates or worldwide UTM (Universal Transverse Mercator) coordinates. Note that the building position should be specified in the same coordinates as the source position and output locations.

---

5. **Height (m)**: height of the building.

   Minimum = 0.001 m
   Maximum = 500 m
   Default = 10 m

6. **Length (m)**: length of a rectangular building or diameter of a circular building. For a rectangular building this is simply one horizontal dimension.

   Minimum = 0.001 m
   Maximum = 1 000 m
   Default = 10 m

7. **Width (m)**: width of a rectangular building, not necessarily smaller than the length. This parameter is not used for a circular building.

   Minimum = 0.001 m
   Maximum = 1 000 m
   Default = 10 m

8. **Angle (°)**: the angle between north and the previously defined **Length**, measured clockwise from north. This is not used for a circular building. Refer to Section 9.8 for a diagram and more information.

   Minimum = 0°
   Maximum = 360°
   Default = 0°

4.1.3 Guidance

A few hints and tips for modelling a building are listed below.

- Buildings such that the building height, H, is less than a fraction ($1/\alpha$) of the source height are ignored when setting up the effective building, so need not be entered. Here $\alpha = 1 + 2*min(1,W/H)$ with W the crosswind width of the building.

- A cluster of similar buildings on a site such as a row of warehouses, may be entered as a single building.
- If there are a large number of buildings on a large site, the user should consider whether to include the one that is nearest to/attached to the source or the one that will have the greatest effect on dispersion (tallest/largest), or consider a higher surface roughness, which can be entered in the **Meteorology** screen, as a means of representing the buildings in a complex site.
- A source inside a building cannot be modelled, though a source on the side or roof of a building can be modelled.

4.2 Advanced meteorological parameters

Advanced meteorological data can be entered for the dispersion site and/or the meteorological measurement site. To enter advanced meteorological data go to the **Meteorology** screen, select the **Use advanced options** box in either of the **Dispersion site** and **Met. measurement site** boxes, then click on **Data...**.

The **Advanced dispersion site data** screen is shown in **Figure 4.3**; the **Advanced met. site data** screen is shown in **Figure 4.4**.

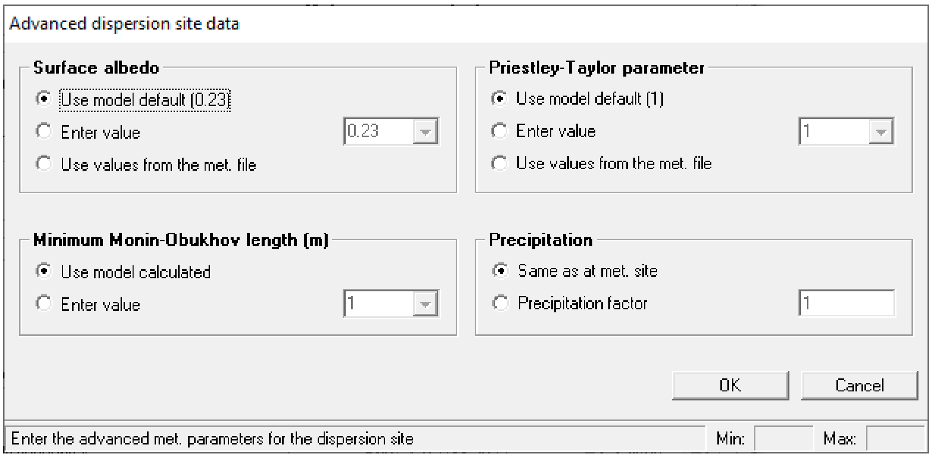


Figure 4.3 − The **Advanced dispersion site data** screen

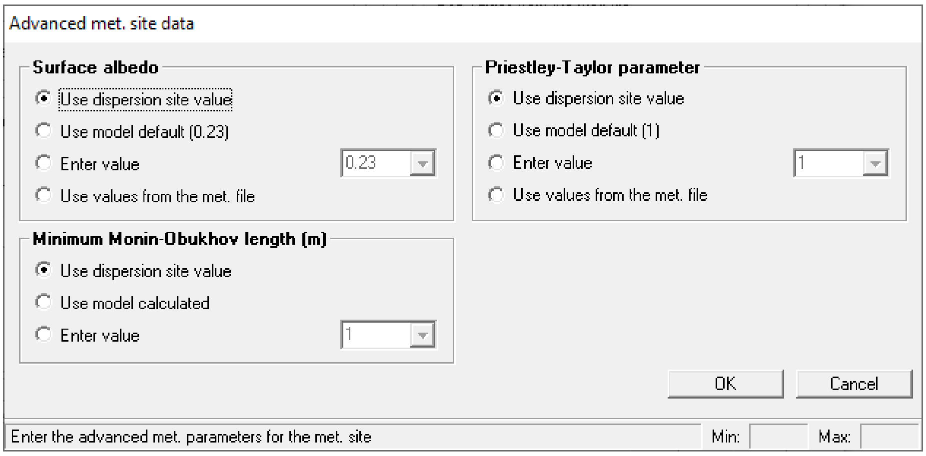


Figure 4.4 − The **Advanced met. site data** screen

The parameters used by ADMS-Screen to process the input meteorological data include the minimum value of the Monin-Obukhov length, the surface albedo and the Priestley-Taylor parameter. The default values of these parameters are defined for a typical rural UK site. ADMS-Screen includes the option to specify values of these parameters more suitable for the site being modelled.

*Note that if the **Use advanced options** box has not been ticked for the **Met. measurement site**, then each of the parameters will take the dispersion site value.*

The option to alter these parameters at either the dispersion or meteorological measurement site is described further in Sections 4.2.1 to 4.2.3. Additionally there is an option to account for differences in precipitation levels between the dispersion site and the meteorological measurement site; this option is described in more detail in Section 4.2.4.

4.2.1 Surface albedo

The surface albedo is the ratio of reflected to incident shortwave solar radiation at the surface of the earth. It therefore lies in the range 0 to 1. In particular, it takes a high value (high proportion of incident radiation reflected) when the ground is snow-covered. The default value for surface radiation is 0.23, i.e. not snow covered (Oke, 1987). The following options are available for the surface albedo.

Use model default (0.23): use the default value; this is the default option for the dispersion site.

Enter value: Enter a user-defined constant value. Either enter a value directly into the box or select a value from the list using the drop down menu:

- **Snow-covered ground** = 0.6
- **Not snow-covered** = 0.23

Use values from the met. file: Use hourly varying values of surface albedo from the meteorological file. Refer to Section 9.1 for details of the variable names to use in the meteorological file.

At the meteorological measurement site there is an additional option of **Use value at dispersion site**; select this to ensure that the surface albedo values at the dispersion site and the meteorological measurement site are the same. This is the default option for the meteorological measurement site.

4.2.2 Priestley-Taylor parameter

The Priestley-Taylor parameter is a parameter representing the surface moisture available for evaporation. The Priestley-Taylor parameter must be between 0 and 3 and the default value is 1 corresponding to moist grassland (Holtslag and van Ulden, 1983). The following options are available for the Priestley-Taylor parameter.

Use model default (1): use the default value; this is the default option for the dispersion site.

Enter value: Enter a constant value. Either enter a value directly into the box or select a value from the list using the drop down menu:

- **Dry bare earth** = 0
- **Dry grassland** = 0.45
- **Moist grassland** = 1

Use values from the met. file: Use hourly varying values of Priestley-Taylor parameter from the meteorological file. See Section 9.1 for details of the variable names to use in the meteorological file.

At the meteorological measurement site there is an additional option of **Use value at the dispersion site**; select this option to ensure that the Priestley-Taylor parameter values at the dispersion site and the meteorological measurement site are the same. This is the default option for the meteorological measurement site.

4.2.3 Minimum Monin-Obukhov length

This is an option to specify the *minimum* value of the Monin-Obukhov length, L_{MOmin}. This allows for the effect of heat production in cities, which is not represented by the meteorological data. The Monin-Obukhov length provides a measure of the stability of the atmosphere (see Section 9.2). In very stable conditions in a rural area its value would typically be 2 to 20 m. In urban areas, there is a significant amount of heat generated from buildings and traffic, which warms the air above the town/city. For large urban areas this is known as the urban heat island. It has the effect of preventing the atmosphere from ever becoming very stable. In general, the larger the area, the more heat is generated and the stronger this effect becomes. This means that in stable conditions the Monin-Obukhov length will never fall below some minimum value; the larger the city, the larger the minimum value. The minimum Monin-Obukhov length should be between 1 and 200 m; the default value is 1 m corresponding to a rural area.

It is useful to note that the minimum value of the Monin-Obukhov length is used by the model to determine a minimum value for the turbulence parameters, $\sigma_{\min}$, in the following way:

(4.1)
$$\sigma_{\min} = \begin{cases} 0.01 & L_{MOmin} \le 10 \\ 0.01 + 0.0095(L_{MOmin} - 10) & 10 < L_{MOmin} < 30 \\ 0.2 & L_{MOmin} \ge 30 \end{cases}$$

The following options are available for the minimum Monin-Obukhov length:

Use model default: use the model default value; this is the default option for the dispersion site.

Enter value: Enter a value, either by typing directly into the box, or by selecting from a list using the drop down menu:

- **Large conurbations > 1 million** = 100 m
- **Cities and large towns** = 30 m
- **Mixed urban/industria**l = 30 m
- **Small towns < 50,000** = 10 m

At the meteorological measurement site there is an additional option of **Use value at dispersion site**; select this option to ensure the minimum Monin-Obukhov lengths at the dispersion site and the meteorological measurement site are the same. This is the default option for the meteorological measurement site.

4.2.4 Precipitation

Using this option will not have any effect on the calculated concentrations output from ADMS-Screen.

SECTION 5 Import and Export

Sections 3 and 4 of this User Guide have described how to set up ADMS-Screen model runs by typing data into boxes in the interface. ADMS-Screen has an import facility allowing for source data to be imported into the ADMS-Screen interface from a set of comma-separated variable files. In addition to source data, pollutant and building data can also be imported in this way. An export facility is also provided, allowing source, pollutant and building data to be exported from the ADMS-Screen interface to comma-separated variable files.

The Mapper also includes an option to facilitate the export of source data within a non-ADMS layer, such as a shape file, to these comma-separated variable files for import into ADMS-Screen. Please refer to the Mapper User Guide for full details, which can be accessed from the **Help** menu of the Mapper.

A description of the files used with the import and export facility is given in Section 5.1. Section 5.2 provides details on importing data and Section 5.3 on exporting data.

5.1 File formats

The import and export facility uses a set of comma-separated files each containing different aspects of the source, pollutant and building data. Each of these files has the same file stem and an extension indicating its contents:

- the *.spt* file contains the main properties of the source including the efflux parameters, i.e. most of the information entered into the **Source** screen of the ADMS-Screen interface.
- the *.vgt* file contains the vertex information for the source
- the *.eit* file contains the pollutant emissions for the source
- the *.ptt* file contains information about pollutant properties, i.e. the information contained in the **Palette of pollutants**
- the *.bpt* file contains information about the building.

Each of these files consists of a version string followed by a header row and then the data. The columns of data can be listed in any order and additional columns can be entered but will not be used during the import process. Full descriptions of the formats of each of these files are given in Sections 5.1.1 to 5.1.5. A facility to create a set of templates for these files is described in Section 5.1.6.

The version strings specifies below (Sections 5.1.1 to 5.1.5) represent the most recent format files. However, it is also possible to import a set of legacy comma-separated variable files into ADMS-Screen that were suitable for previous versions of the model.

5.1.1 .spt file

The *.spt* file contains information about the source. The first line of the *.spt* file must contain the version information `SPTVersion2`. The header line details and data required are described in **Table 5.1**.

Many of the parameters in the .spt file only apply for certain source types, or if certain model options are in use, which are not available in ADMS-Screen. For parameters which are not required fill in 0 or n/a.

Header	Description
`Source name`	Source name.
`Use VAR file`	Not used in ADMS-Screen.
`Specific heat capacity (J/kg/K)`	Specific heat capacity of the release in Joules per kilogram per Kelvin. The ADMS-Screen default value is 1012.
`Molecular mass (g)`	Molecular mass of the release in grams. The ADMS-Screen default value is 28.966.
`Temperature or density?`	Is the release temperature or density specified? Enter the keyword `Temperature`, `Density` or `Ambient`.
`Temperature (Degrees C) / Density (kg/m3)`	Temperature or density of the release in appropriate units.
`Actual or NTP?`	Is the efflux specified at the temperature or at NTP? Enter the keyword `Actual` or `NTP`.
`Efflux type keyword`	There are 4 options for specifying the efflux. Enter the keyword `Velocity`, `Volume`, `Mass` or `Momentum`.

`Velocity (m/s)`
`Volume flux (m3/s)`
`Momentum flux (m4/s2)`
`Mass flux (kg/s)`
	Efflux in appropriate units.

`Heat release rate (MW)`	Indication of buoyancy flux (Fb) in mega Watts if `Momentum` is selected as the efflux type.
`Source Type`	The type of the source. Enter the keyword `Point`, as this is the only source type available in ADMS-Screen.
`Height (m)`	Height of the source, in metres.
`Diameter (m)`	Diameter of the point source, in metres.

`Line width (m) /`
`Volume depth (m) /`
`Road width (m) /`
`Grid depth (m)`
	Not used in ADMS-Screen.

`Canyon height (m)`	Not used in ADMS-Screen.
`Angle 1 (deg)`	Not used in ADMS-Screen.
`Angle 2 (deg)`	Not used in ADMS-Screen.
`Mixing ratio (kg/kg)`	Not used in ADMS-Screen.
`Traffic flows used`	Not used in ADMS-Screen.
`Traffic flow year`	Not used in ADMS-Screen.
`Traffic flow road type`	Not used in ADMS-Screen.
`Main building`	The selection of main building. Enter the keyword `(Main)`, `(None)`, `(Auto)` or the name of the building.
`Comments`	Further comments may be added here, which will not be included in the *.apl* file.

Table 5.1 – Data to be entered in the *.spt* file.

5.1.2 .vgt file

The *.vgt* file contains vertex information for the source. The first line of the *.vgt* file must contain the version information `VGTVersion2`. The header line details and data required are described in **Table 5.2**. Only one vertex should be entered for a point source.

Header	Description
`Source name`	Source name
`X (m)`	X coordinate of the vertex, in metres
`Y (m)`	Y coordinate of the vertex, in metres

Table 5.2 – Data to be entered in the *.vgt* file.

5.1.3 .eit file

The *.eit* file contains pollutant emissions information for the source. The first line of the *.eit* file must contain the version information `EITVersion1`. The header line details and data required are described in **Table 5.3**. Separate lines should be entered for each pollutant emitted from the source.

Header	Description
`Source name`	Source name
`Pollutant name`	Pollutant name
`Emission rate`	Emission rate of the pollutant in grams per second

Table 5.3 – Data to be entered in the *.eit* file.

5.1.4 .ptt file

The *.ptt* file contains property data for all pollutants. The first line of the *.ptt* file must contain the version information `PTTVersion2`. The header line details and data required are described in **Table 5.4**. For gaseous pollutants a single line of data must be entered for each pollutant, for particulate pollutants separate lines of data should be entered for each particulate component.

Note that, as deposition cannot be modelled in ADMS-Screen, none of the variables entered into **Table 5.4** related to deposition will be used in the modelling.

Header	Description
`Pollutant name`	Name of the pollutant.
`Pollutant type`	Type of pollutant. Enter the keyword `Gas` or `Particulate`.
`Deposition vel. known`	Is the deposition velocity known? Enter the keyword `Yes` or `No`.
`Terminal vel. known`	For particulate pollutants, is the terminal velocity known? Enter the keyword `Yes` or `No`.
`Washout coeff known`	Is the washout coefficient known? Enter the keyword `Yes` or `No`.
`Washout coeff.`	Washout coefficient independent of precipitation rate.
`Washout coeff. A`	Parameter A in expression for washout coefficient dependent on precipitation rate.
`Washout coeff. B`	Parameter B in expression for washout coefficient dependent on precipitation rate.
`Conversion factor (ug/m3 -> ppb)`	For gaseous pollutants, the conversion factor from ug/m3 to parts per billion by volume (ppb).
`Nature of gas`	For gaseous pollutants, the nature of the gas. Enter the keyword `Non-reactive`, `Reactive` or `Inert`.
`Deposition velocity (m/s)`	Rate at which material is deposited to the ground due to diffusion in metres per second.
`Terminal velocity (m/s)`	For particulate pollutants, the rate at which material is deposited to the ground due to gravitational settling in metres per second.
`Particle diameter (m)`	For particulate pollutants, the diameter of the particles in metres.
`Particle density (kg/m3)`	For particulate pollutants, the density of the particles in kg/m^3.
`Mass fraction`	For particulate pollutants, the mass fraction of this diameter/density combination. The total mass fraction for each pollutant must add up to 1.

Table 5.4 – Data to be entered in the *.ptt* file.

5.1.5 .bpt file

The *.bpt* file contains data for the building. The first line of the *.bpt* file must contain the version information `BPTVersion1`. The header line details and data required are described in **Table 5.5**. The building is represented by one row of data.

Header	Description
`Name`	Building name.
`Shape`	Shape of the building. Enter the keyword `Rectangular` or `Circular`.
`X (m)`	X coordinate of the building centre, in metres.
`Y (m)`	Y coordinate of the building centre, in metres.
`Height (m)`	Height of the building, in metres.
`Length (m) / Diameter (m)`	Length of a rectangular building or diameter of a circular building, in metres.
`Width (m)`	Width of a rectangular building, in metres.
`Angle (degrees)`	Angle the length of a rectangular building makes with north, measured clockwise in degrees.

Table 5.5 – Data to be entered in the *.bpt* file.

5.1.6 Import templates

A set of blank template files can be created by selecting **Create import templates** from the **Utilities** menu of the ADMS-Screen interface. This option creates a blank set of template files with the appropriate headers in a location of the user's choosing. These files can be edited in a spreadsheet package and then imported into ADMS-Screen using the **Import** option from the **File** menu.

5.2 Import

To import the source, pollutant and/or building data from a set of *.csv* files, select **Import** from the **File** menu to start the **Import wizard**, **Figure 5.1**. Alternatively, drag and drop an *.spt* file onto the title bar of the ADMS-Screen interface to start the **Import wizard**. The **Import wizard** consists of a series of screens guiding you through the import process, some of these screens only appear if certain import options are selected. Navigate through the screens using the **Next >** and **< Previous** buttons. Sections 5.2.1 to 5.2.7 describe each of the screens of the **Import wizard**.

5.2.1 Select files to import

The first screen of the **Import wizard**, shown in **Figure 5.1**, is used to select the files to be imported.

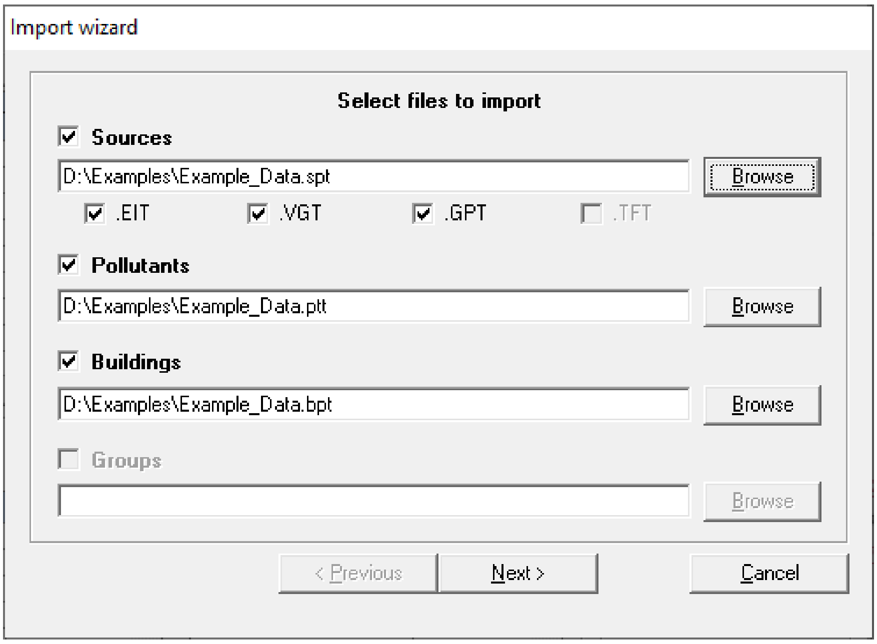


Figure 5.1 –**Select files to import** screen of the **Import wizard**.

There are four main file types which can be selected for import:

- **Sources**, (*.spt*) – select this option to import the source details. When an *.spt* file is selected the other files corresponding to this are also automatically selected for import. The presence of an *.eit* or *.vgt* file is indicated by the check boxes below, these can be deselected to prevent importing the data from that file.
- **Pollutants**, (*.ppt*) – select this option to import pollutants. By default, the *.ppt* file associated with the *.spt* file will be used; however you can browse to select an alternative *.ppt* file.
- **Buildings**, (*.bpt*) – select this option to import building details. As with *.ppt* files, the *.bpt* file associated with the *.spt* file is used by default, but an alternative file can be selected.

- **Groups**, (*.gpt*) – Not available in ADMS-Screen.

Once the files to be imported have been selected click **Next >** to move onto the next screen of the **Import wizard**.

5.2.2 Filter sources by type

If a source is selected for import the next screen of the **Import wizard** is the **Filter sources by type** screen, shown in **Figure 5.2**. This screen will only show the option to import one point source in ADMS-Screen.

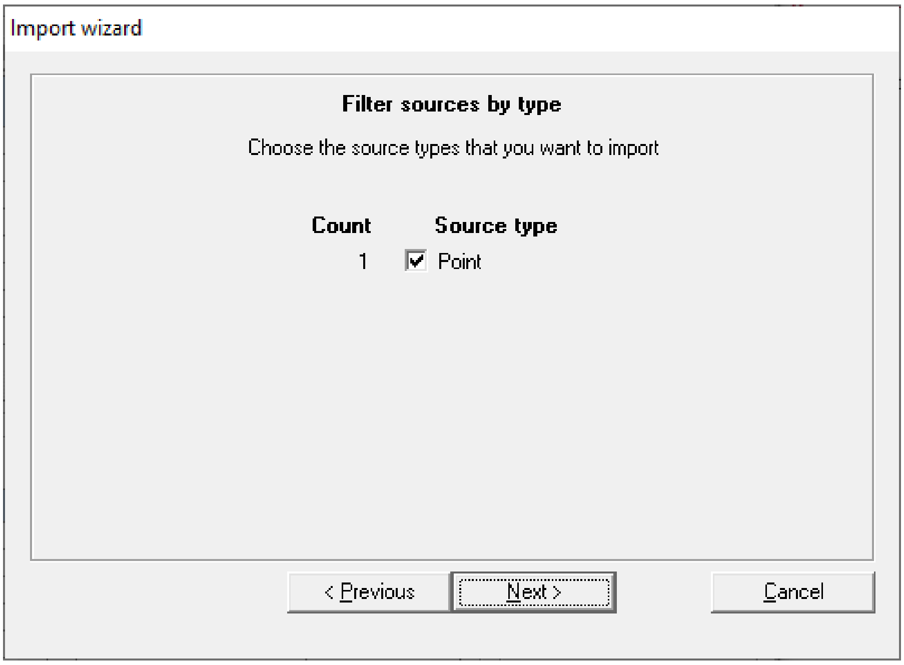


Figure 5.2 – **Filter sources by type** screen of the **Import wizard**.

Once the required source type is selected click **Next >** to move to the **Select sources** screen.

5.2.3 Select sources

The **Select sources** screen allows for selection of individual sources to be imported, shown in **Figure 5.3**.

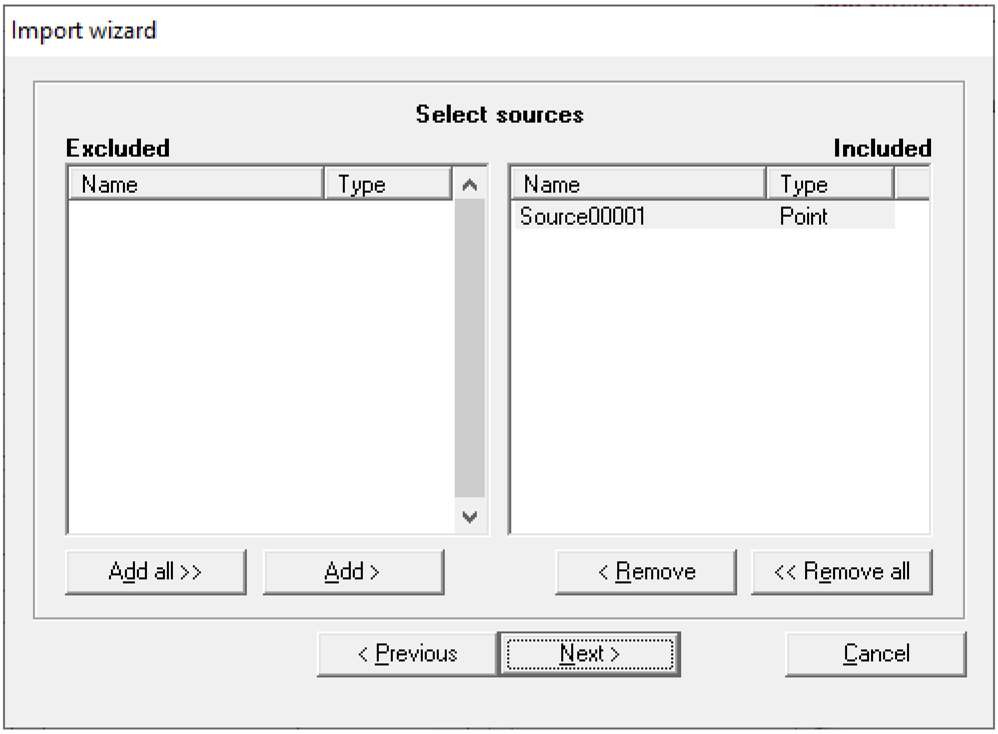


Figure 5.3 – **Select sources** screen of the **Import wizard**.

Sources listed on the right hand side will be imported whereas sources on the left will not be imported. By default, all sources from the *.spt* file will be selected for import. The **Add >** and **Add All >>** buttons can be used to include sources in the import, the **< Remove** and **<< Remove All** buttons can be used to exclude sources from the import. Sources can also be **Included**/**Excluded** for import by double-clicking on the source name or dragging them to the appropriate side. The sources can be ordered by clicking on the **Name** and **Type** headers.

Note that only one point source can be imported into ADMS-Screen. Once the required source is selected for import, click the **Next >** button.

5.2.4 Source settings

If the source being imported has the same name as a source already defined in the ADMS-Screen interface the **Source settings** screen will appear, shown in **Figure 5.4**.

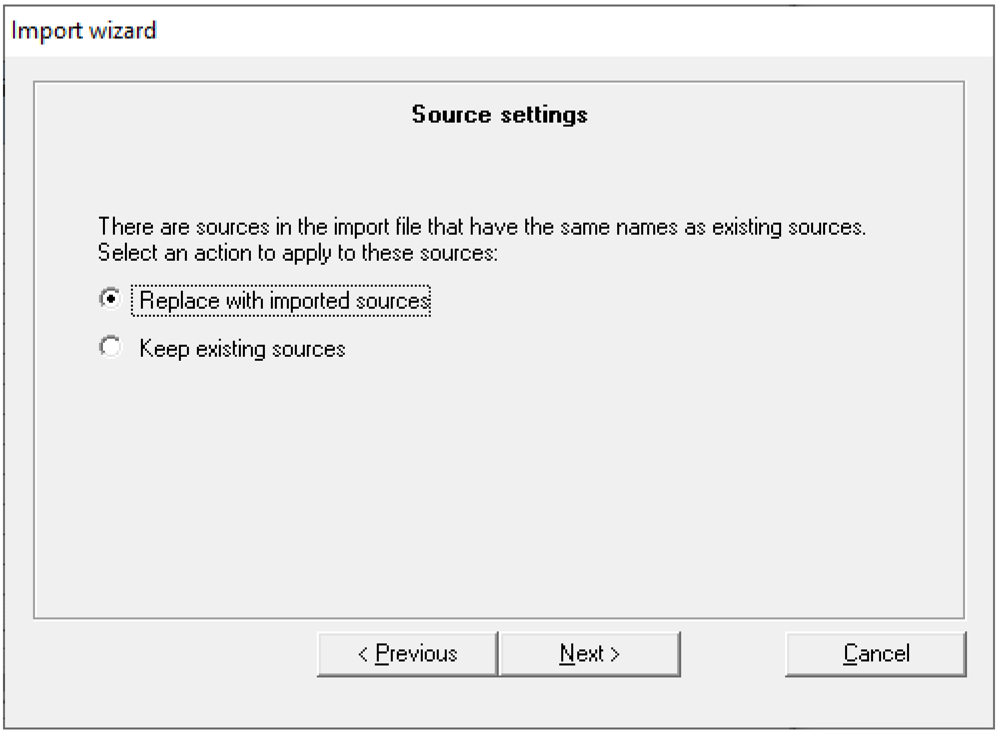


Figure 5.4 – **Source settings** screen of the **Import wizard**.

This screen has two options:

- **Replace with imported sources** – select this option to replace the existing source definition with that contained in the import file.
- **Keep existing sources** – select this option to keep the source definition already in the ADMS-Screen interface.

Click **Next >** to move to the next screen of the **Import wizard.**

5.2.5 Pollutant settings

If pollutants are being imported the **Pollutant settings** screen will appear, shown in **Figure 5.5**.

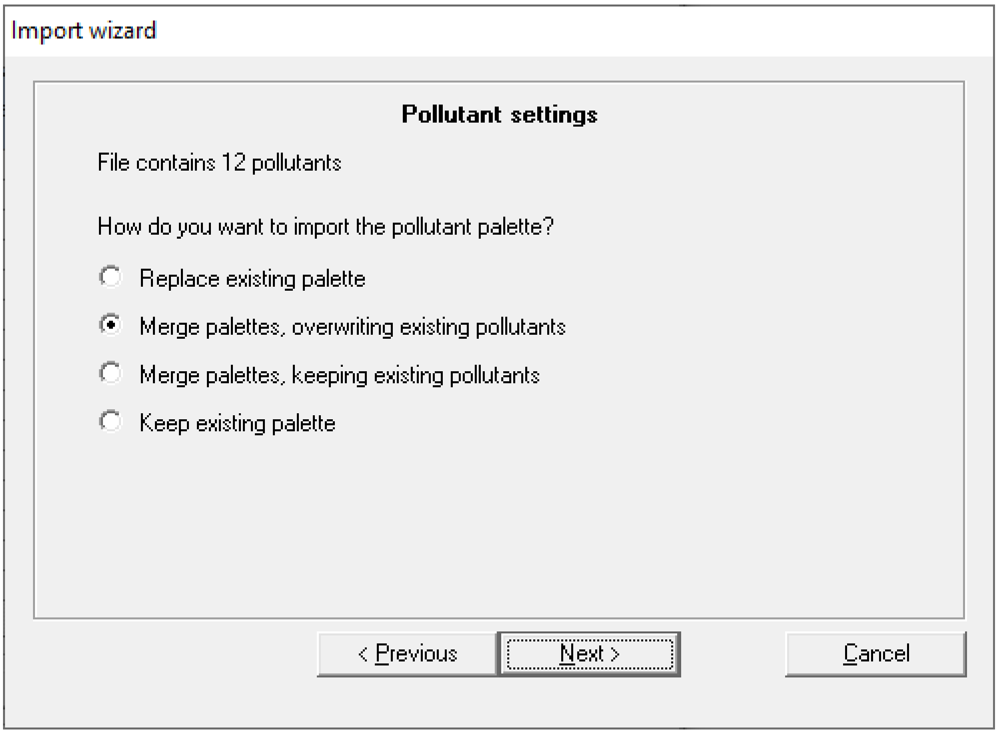


Figure 5.5 – **Pollutant settings** screen of the **Import wizard**.

This screen has four options:

- **Replace existing palette** – all pollutants from the *.ptt* file will be imported, all existing pollutants, except for `NOx`, `NO2`, `NO`, `O3` and `VOC`, will be deleted.
- **Merge palettes, overwriting existing pollutants** – all pollutants from the *.ptt* file will be imported, existing pollutants will be kept providing their names don't match any in the *.ptt* file.
- **Merge palettes, keeping existing pollutants** – all existing pollutants will be kept, any pollutants not already in the palette will be imported.
- **Keep existing palette** – no pollutants will be imported

Click **Next >** to move to the next screen of the **Import wizard.**

5.2.6 Building settings

If a building is being imported and the building is already defined in the ADMS-Screen interface, the **Building settings** screen will appear, shown in **Figure 5.6**.

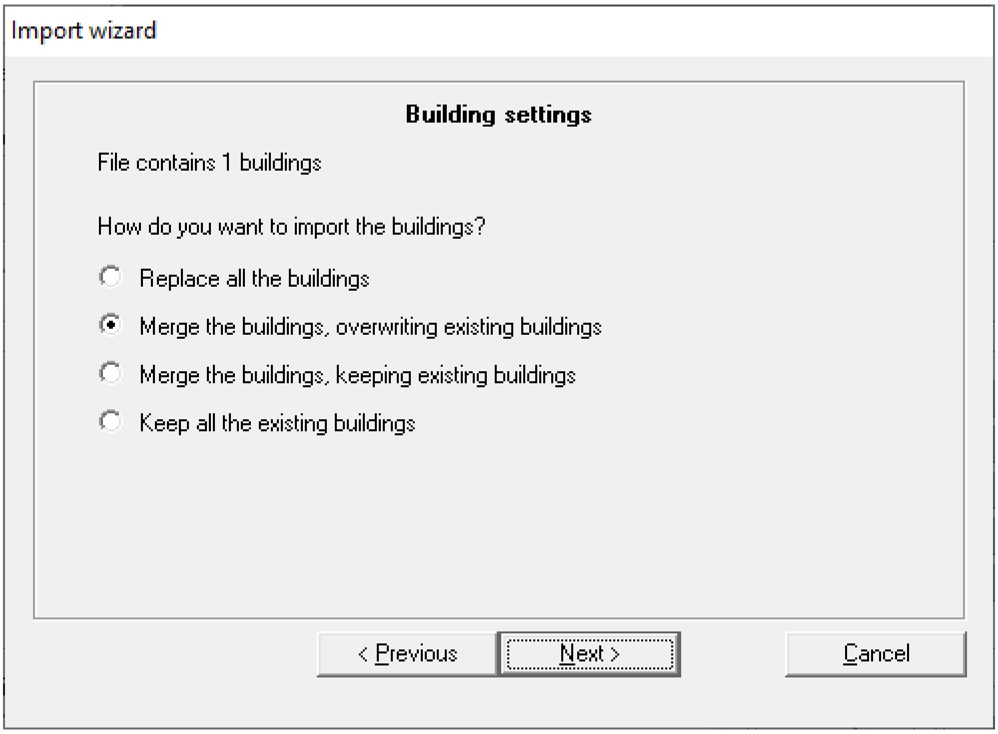


Figure 5.6 – **Building settings** screen of the **Import wizard**.

This screen has four options:

- **Replace all the buildings** – the building from the *.bpt* file will be imported, any existing building will be deleted
- **Merge the buildings, overwriting existing buildings** – will behave in the same way as **Replace all the buildings** in ADMS-Screen
- **Merge the buildings, keeping existing buildings** – will behave in the same way as **Keep all the existing buildings** in ADMS-Screen
- **Keep all the existing buildings** – the building will not be imported

Click **Next >** to move to the next screen of the **Import wizard**.

5.2.7 Check import

The final screen of the **Import wizard** is the **Check import** screen, shown in **Figure 5.7**.

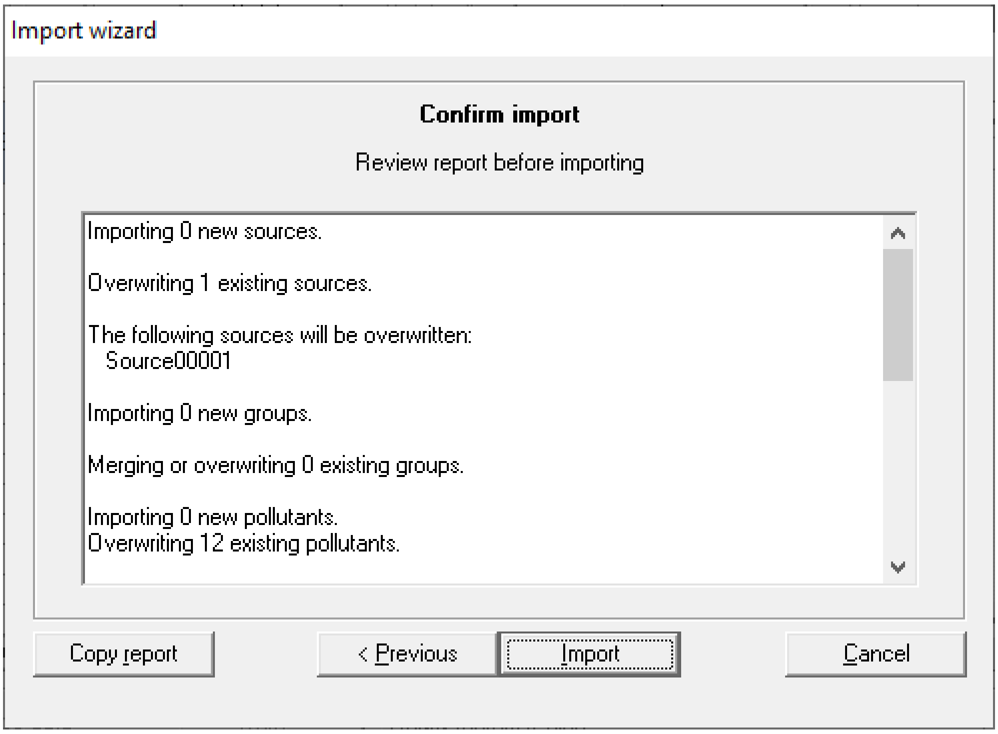


Figure 5.7 – **Check import** screen of the **Import wizard**.

This screen provides a report indicating the source, pollutants and building which will be imported or overwritten along with other information messages. The **Copy report** button can be used to copy the report data to the clipboard. To import the data click on **Import** or click **< Previous** to alter what should be imported.

5.3 Export

It is also possible to export source, pollutant and building data from ADMS-Screen into a set of comma-separated variable files. You can use this method to transfer data to other *.apl* files, or to manipulate the data in a spreadsheet package before re-importing.

To export data from the ADMS-Screen interface select **Export** from the **File** menu to open the **Export** screen, shown in **Figure 5.8**.

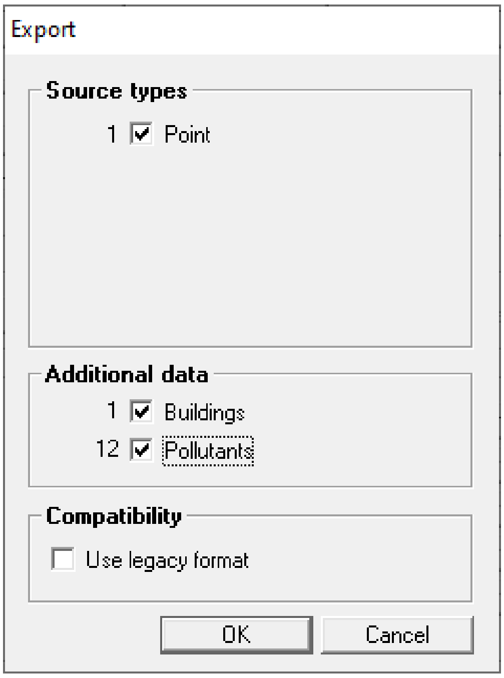


Figure 5.8 – **Export** screen.

The **Export** screen allows for the selection of the **Source types** to be exported along with options to export the **Buildings** and **Pollutants** data. Once the items to be exported have been selected click **OK** to open the **Save** dialogue. Enter a directory and filename stem then click **Save**, a set of comma-separated variable files will be created, see Section 5.1 for details of which files will be created based on the options selected.

If the **Use legacy format** option is ticked, the comma-separated variable files will be generated using the older format used in previous versions of ADMS-Screen.

SECTION 6 Model Output

A variety of output data is produced by ADMS-Screen according to the run configuration. This section describes each possible output and presents the tools available in ADMS-Screen to visualise the results of a run.

Section 6.1 describes the different types of files produced by ADMS-Screen. Sections 6.2 to 6.5 describe some of the other elements of the **Results** menu of the interface of ADMS-Screen, as shown in **Figure 6.1**.

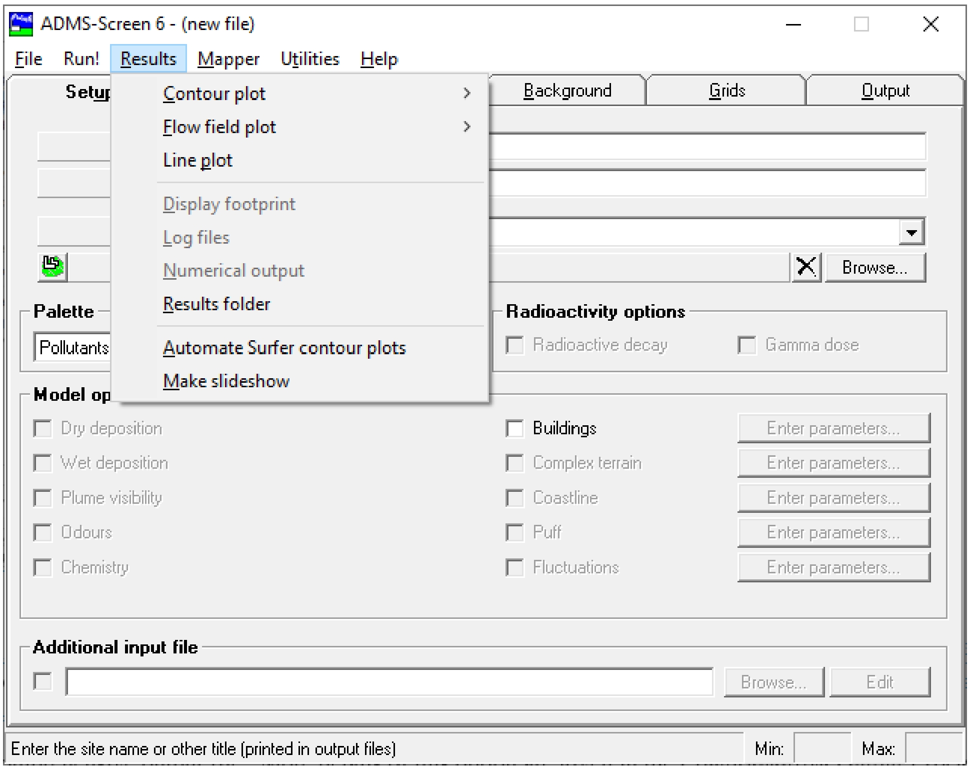


Figure 6.1 – Results menu.

The first and third options of the menu are used for visualising the results produced by ADMS-Screen in different ways: contour plots of concentration (**Contour plot**) (Section 6.2), and plots of plume centreline properties (**Line Plot**) (Section 6.3).

The second (**Flow field plot**) and fourth (**Display footprint**) options are not applicable to ADMS-Screen.

The fifth option (**Log files**) is a utility for visualising the error, warning and log files produced during the run (Section 6.4).

The sixth option (**Numerical output**) launches a window listing all files in the folder containing the model file. A particular output file can then be selected and opened in the preferred application (Section 6.5).

The seventh option (**Results folder**) opens an Explorer window containing the directory of the currently loaded *.apl* file.

The last two options on the **Results** menu start up Excel templates containing macros to automate the creation of contour plots in Surfer and 'slideshows' of *.gif* images. For more details on these items refer to the *Surfer Automation and Slideshow Creator User Guide*, which can be found in the *<install_path>\Documents* directory.

6.1 ADMS-Screen output files

During an ADMS-Screen model run, a series of output files is created. These files contain the results of the run and are stored in the same directory as the corresponding *.apl* run file. The number of output files produced depends on the run configuration, for example the type of input file and the selected options.

All output files for a model run have the same file stem as the *.apl* file stem and are associated with a different extension that indicates the type of output data contained in the file. For instance, should the *.apl* file be *example.apl*, the output files could be as follows:

example.!01, example.cen, example.glt, example.gst, example.log, example.max, example.mop, example.plt, example.pst

Each of the possible output files is described in the following sections.

The majority of the ADMS-Screen output files are in a text-based format. As an alternative to using the ADMS-Screen results utilities, the user can view them directly with a text editor, for example Notepad.

6.1.1 .err, .wng and .log files

These files provide useful information about the model run.

The *.err* file (error) is a text file produced if an error occurs during the run that causes the model to stop. In verification mode, the file may contain several errors. Each error must be corrected before the model can run the *.apl* file successfully.

The *.wng* (warning) file contains any warning messages produced during the run. These are non-fatal errors, i.e. they do not cause the model to stop. The user should check that for each of these warnings the required behaviour is being followed, and make adjustments to model input if necessary.

The *.log* file contains a log of the model run. It details the date and time of the start and end of the run, any program messages, and a summary of the meteorological data (including the number of lines of data the model was able to use).

6.1.2 .cen file

The *.cen* file (plume centreline) contains a series of data related to the plume, which are detailed in **Table 6.1**. It is only produced for short-term calculations with gridded output.

Output values are given for the first 24 lines of meteorological data only, to prevent the output file from becoming too large.

When the **Buildings** option is selected, the values refer to the (idealised un-split) elevated plume only.

Variable	Description
C(0)	ground-level concentration below the plume centreline
C(Zp)	concentration along the plume centreline
Sig-y	plume spread parameter in the crosswind direction
Sig-z	plume spread parameter in the vertical direction
Zp	height of the plume centreline
Zm	mean height of the plume
PINV	fraction of the plume that has penetrated the top of the boundary layer
YP	crosswind plume centreline position
Time	travel time from the source

Table 6.1 − Variables contained in a *.cen* file.

6.1.3 .glt and .plt files

The *.glt* file (gridded, long-term) contains output values resulting from long-term average calculations for the modelled source at every point of the output grid. The possible output variables are listed in **Table 6.2**.

The *.plt* (points, long-term) file is equivalent to the *.glt* file except that output values are given for every specified point defined in the **Grids** screen.

Variable	Description
LTConc	mean concentration
If percentiles selected:	
P###.##	percentile (e.g. P99.9)
If exceedences selected:	
EXpaM	number of exceedences per annum of each concentration threshold value

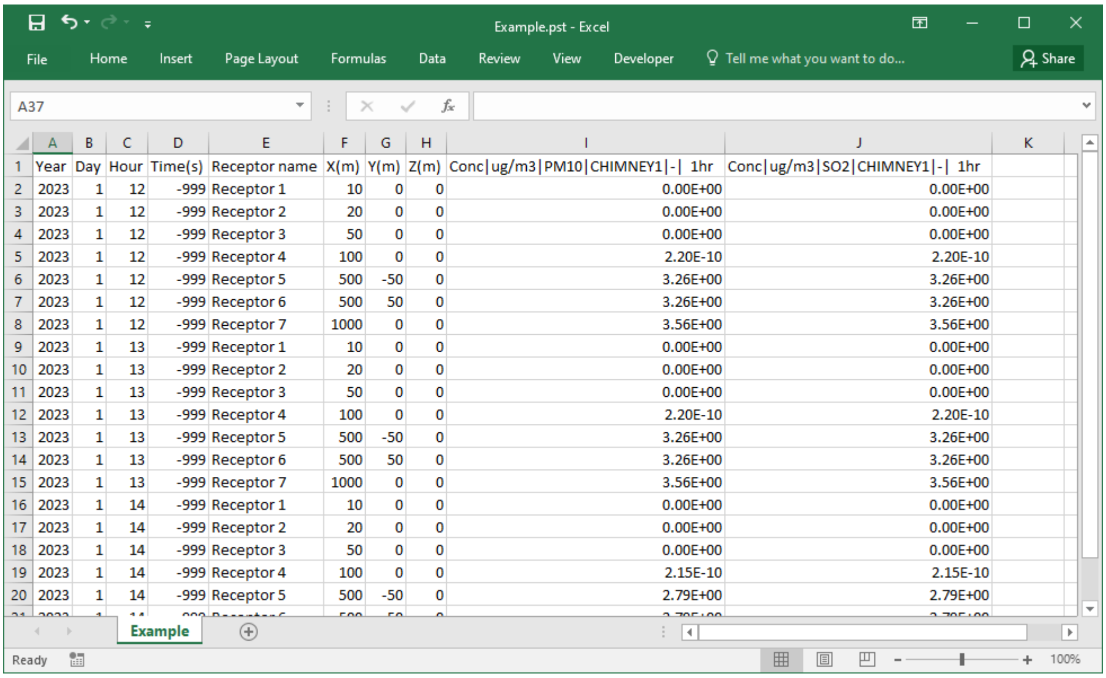
Table 6.2 − Variables contained in a *.glt* file.

6.1.4 .gst and .pst files

The *.gst* file (gridded, short-term) contains output concentration values resulting from short-term calculations for the modelled source at every point of the output grid and for each line of meteorological data. Output values are given for the first 24 lines of meteorological data only, to prevent the output file becoming too large.

The *.pst* file (points, short-term) is equivalent to the *.gst* file except that output values are given for every specified point defined in the **Grids** screen.

An examples of a *.pst* file (viewed in Microsoft Excel) is illustrated in **Figure 6.2**. Gridded *.glt* and *.gst* files are similar to these files but with a value for every grid point.



	A	B	C	D	E	F	G	H	I	J
1	Year	Day	Hour	Time(s)	Receptor name	X(m)	Y(m)	Z(m)	Conc|ug/m3|PM10|CHIMNEY1|-| 1hr	Conc|ug/m3|SO2|CHIMNEY1|-| 1hr
2	2023	1	12	-999	Receptor 1	10	0	0	0.00E+00	0.00E+00
3	2023	1	12	-999	Receptor 2	20	0	0	0.00E+00	0.00E+00
4	2023	1	12	-999	Receptor 3	50	0	0	0.00E+00	0.00E+00
5	2023	1	12	-999	Receptor 4	100	0	0	2.20E-10	2.20E-10
6	2023	1	12	-999	Receptor 5	500	-50	0	3.26E+00	3.26E+00
7	2023	1	12	-999	Receptor 6	500	50	0	3.26E+00	3.26E+00
8	2023	1	12	-999	Receptor 7	1000	0	0	3.56E+00	3.56E+00
9	2023	1	13	-999	Receptor 1	10	0	0	0.00E+00	0.00E+00
10	2023	1	13	-999	Receptor 2	20	0	0	0.00E+00	0.00E+00
11	2023	1	13	-999	Receptor 3	50	0	0	0.00E+00	0.00E+00
12	2023	1	13	-999	Receptor 4	100	0	0	2.20E-10	2.20E-10
13	2023	1	13	-999	Receptor 5	500	-50	0	3.26E+00	3.26E+00
14	2023	1	13	-999	Receptor 6	500	50	0	3.26E+00	3.26E+00
15	2023	1	13	-999	Receptor 7	1000	0	0	3.56E+00	3.56E+00
16	2023	1	14	-999	Receptor 1	10	0	0	0.00E+00	0.00E+00
17	2023	1	14	-999	Receptor 2	20	0	0	0.00E+00	0.00E+00
18	2023	1	14	-999	Receptor 3	50	0	0	0.00E+00	0.00E+00
19	2023	1	14	-999	Receptor 4	100	0	0	2.15E-10	2.15E-10
20	2023	1	14	-999	Receptor 5	500	-50	0	2.79E+00	2.79E+00

Figure 6.2 − An example of a *.pst* file.

6.1.5 .max file

The *.max* file (maximum concentrations) contains the maximum value of the mean concentration and each of the percentiles selected, the position of the maximum values and, in the case of the percentiles, for which line of meteorological data the maximum values occur. It is created when a long-term average calculation is made, with or without percentiles.

In addition, following each maximum percentile value, the concentrations exceeding that value at that point are listed, alongside the line number of the meteorological data for which they occur. For example, when using one year of data (8760 lines), there will be 2% of 8760 lines (176) where the 98th percentile value is exceeded. This output is only given for the 98th percentile and above.

6.1.6 .mop file

The *.mop* file (meteorological input and output parameters) contains the meteorological input parameters and the calculated meteorological output values for each line of data in the meteorological data file. The frequency of occurrence of each condition is also reported for statistical meteorological data. The input parameters are in the left hand columns of the file, and the calculated output parameters in the right hand columns.

6.1.7 .!01 extensions

The *.!01*, *.!02*, etc. files are files used by the **Line Plot** utility of ADMS-Screen (see Section 6.3). They are only produced for short-term calculations with gridded output. The number in the extension refers to the line of meteorological data to which the results correspond.

6.2 Contour plots

This section outlines how to produce contour plots from gridded ADMS-Screen output data using the **2-D Output Plotter** utility, launched from the ADMS-Screen interface via the **Results** menu. It is possible to produce contour plots in either the Mapper or Surfer (if installed). Selecting one of these brings up the screen shown in **Figure 6.3**.

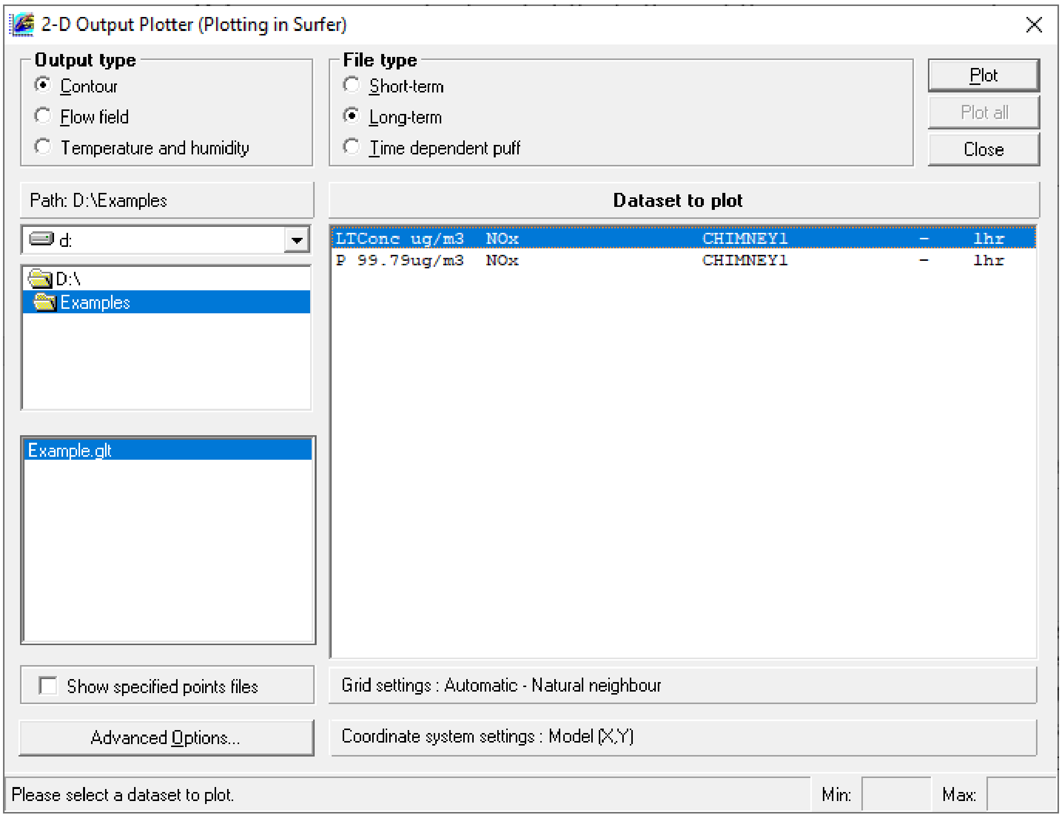


Figure 6.3 – The **2-D Output Plotter** screen.

The **2-D Output plotter** allows for plotting many different types of gridded output from ADMS-Screen. The **Output type** should first be selected:

- **Contour**: for plotting contour plots of data output to the *.gst* or *.glt* file.

6.2.1 Contour

When **Contour** is selected as the **Output type** the **2-D Output plotter** will look as shown in **Figure 6.3**. Here are the steps to follow in order to create a contour plot of data:

Step 1 Choose the file type from **Short-term** and **Long-term** (at the top of the screen). This defines the types of files listed in the lower left hand box. If **Short-term** is chosen, all the files with the extension *.gst* (in the chosen directory) are listed, if **Long-term** is chosen, all the files with the extension *.glt* are listed.

Checking the **Show specified points files** *box also allows for specified points files (*.pst, .plt*) to be plotted providing they contain sufficient points.*

Step 2 Select the appropriate folder and click on the name of the file containing the data to plot. Right-clicking on **Path:** allows the path of a file or directory to be pasted in. Files or directories can also be dragged from Explorer onto **Path:** to use that file or directory.

Step 3 Click on the dataset to plot (**Dataset to Plot** box), and if relevant also click on the time for which the data are to be plotted (**Time (year, day, hour)** box).

The **Dataset to Plot** box shows a list of all the variables that can be used for the plot. Each record in the list shows the type of output (e.g. 'Conc' for concentration), the units of output (e.g. 'ppm'), the pollutant name (e.g. 'CO'), the source name (e.g. 'Power Station'), whether it is a rolling average ('R' or '-'), and the averaging time (e.g. '1hr').

For short-term runs only, a **Time (year, day, hour)** box is also displayed. The box displays the time (year, day, hour) as given in the meteorological data irrespective of whether these data are entered from a file or by hand. If no time information is given in the meteorological data file, numbers corresponding to each consecutive meteorological condition are used. For example, numbers 1 to 7, corresponding to meteorological conditions A to G respectively, are listed when the example file *R91a-g.met* is used.

Step 4 Click on the **Advanced Options...** button to set some properties of the plot (optional – refer to Section 6.2.2 for details).

Step 5 Click on **Plot** to plot the selected data in the Mapper / Surfer.

The ADMS-Screen output file is converted to a grid file (.grd*) for the Mapper/Surfer to plot. Save this to an appropriate location.*

In the upper right hand corner, the **Close** button closes the **2-D Output Plotter**. The **Plot all** button is related to output created using the **Spatial splitting** option in ADMS-Urban and is not available for ADMS-Screen output.

If you are creating many contour plots then you may wish to use the Surfer Automation tool. Details of this tool can be found in the Surfer Automation and Slideshow Creator Tools User Guide (SurferAutomationandSlideshowCreator_UserGuide.pdf) located in the Documents subdirectory of the ADMS-Screen installation directory.

6.2.2 Advanced options

The **Advanced Options...** button gives the user a number of options to enhance the plot. Clicking on it brings up the **Advanced Options** screen shown in **Figure 6.4**. From that screen, you can set the contour levels, the coordinate system of the grid, the gridding options, and whether to overlay the terrain file.

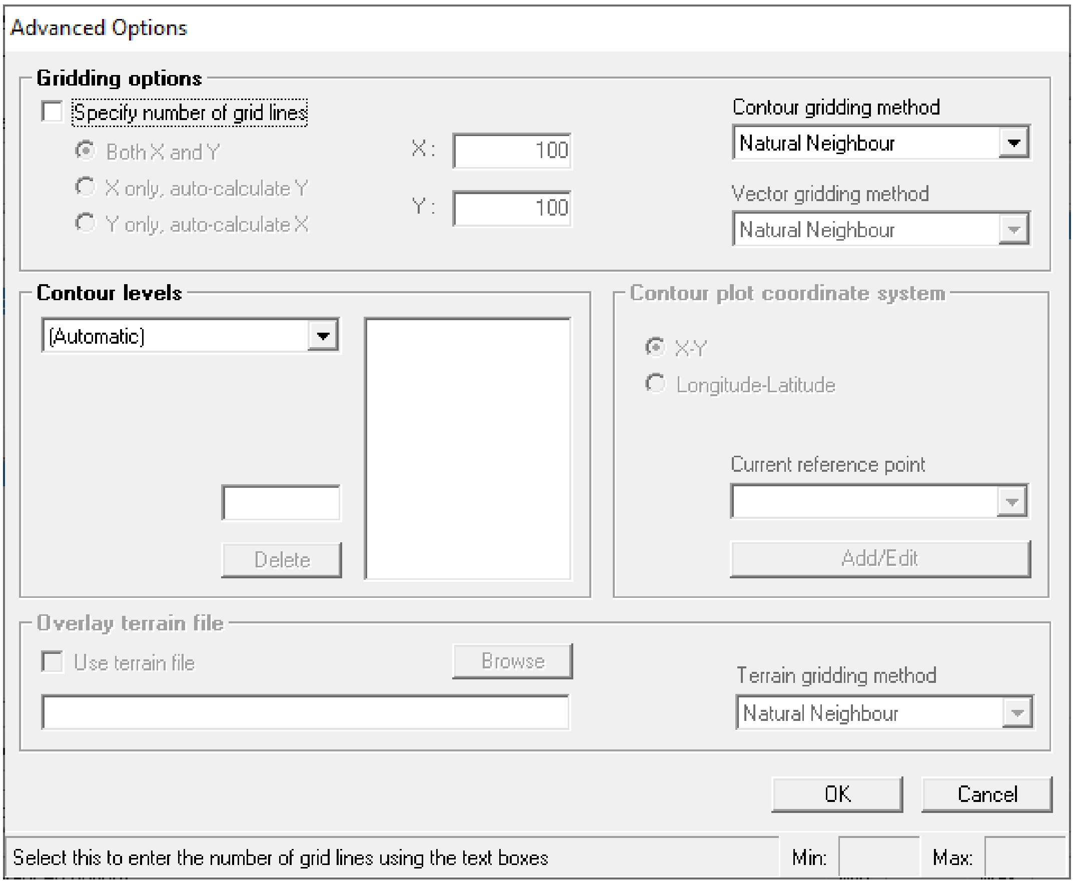


Figure 6.4 − The **Advanced Contour Options** screen.

When you have finished with the **Advanced Options** screen, click on the **OK** button to return to the **2-D Output Plotter** main screen. Once the required information has been selected in this screen, click on **Plot** to create the plot.

*Some of the options on the **Advanced Options** screen are only available for some plot types.*

Further help with using Surfer is given in Appendix D.

Gridding options

A number of different gridding methods for a contour plot can be selected from the **Contour Gridding method** drop-down list. Information about the available gridding methods can be found in the Surfer user guide.

To specify the grid resolution, tick the **Specify number of grid lines** box. Select the appropriate option to specify the number of grid lines in both the X and Y directions, or in one direction only. If the number of lines is specified in one direction only, the contouring interface will ensure that the resolution is the same in the X and Y directions. Enter the number of grid lines in the **X:** and/or **Y:** boxes.

*If the **Specify number of grid lines** option is not selected, the **2-D Output Plotter** will choose the resolution based on the resolution of the results to be plotted.*

Contour levels

To choose the contour levels to plot, click on **(User-specified)** from the drop-down list. For each level you want to plot (up to a maximum of 40 levels), type the level value in the small box above the **Delete** button and press the space bar to enter it into the larger box. If you want to delete any level, click on that number in the larger box and click on the **Delete** button.

Contour plot coordinate system

When plotting in Surfer, to convert your output from X-Y coordinates to longitude-latitude coordinates, select **Longitude-Latitude** and then click on **Add/Edit**. You must supply the X-Y and longitude-latitude coordinates of a reference point, as shown in **Figure 6.5** (left). Longitude and latitude should typically be given to 6 decimal places.

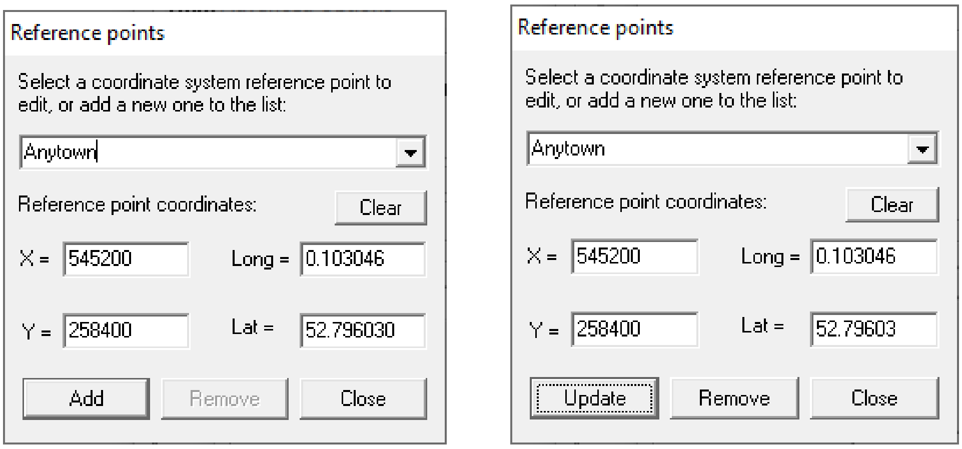


Figure 6.5 − Left: entering coordinates of a datum point. Right: revising and updating coordinates of a datum point.

In the UK, the X-Y coordinates will typically be national grid (OSGB) references.

Click on **Add** to store the coordinate data and on **Close** to leave the screen. Datum information can be deleted by clicking on **Remove** or revised by entering the new data and then clicking on **Update** as in **Figure 6.5** (right).

If you have entered several datum points, because you are studying sites in different locations that use different local co-ordinate systems, choose the appropriate datum point from the drop down list.

The **Grid settings** and the **Coordinate system** selected on the **Advanced Options** screen are displayed at the bottom of the main screen, as shown at the bottom of **Figure 6.3**.

6.3 Line plots (ADMS Line Plotter)

ADMS-Screen has an integrated line plot utility called **ADMS Line Plotter**. This can only be used with model runs where short-term gridded output is selected. Concentration and plume dispersion data are plotted along a line of points extending in the downstream direction from the source, i.e. along the 'plume centreline', as far as the downstream edge of the output grid.

The **ADMS Line Plotter** uses a specific type of file to produce the plots. The files have the extension *.!n* for plumes, where *n* is a two-digit number corresponding to the line of meteorological data of the *.met* file used in the model run (see Section 6.1.7). These files contain the same information as the *.cen* file but they have been formatted so that they can be read by the graphical interface. *They are not intended to be read and/or interpreted by the user*.

To launch the **ADMS Line Plotter**, select **Results**, **Line Plot** from the main ADMS-Screen interface. This brings up the screen shown in **Figure 6.6**.

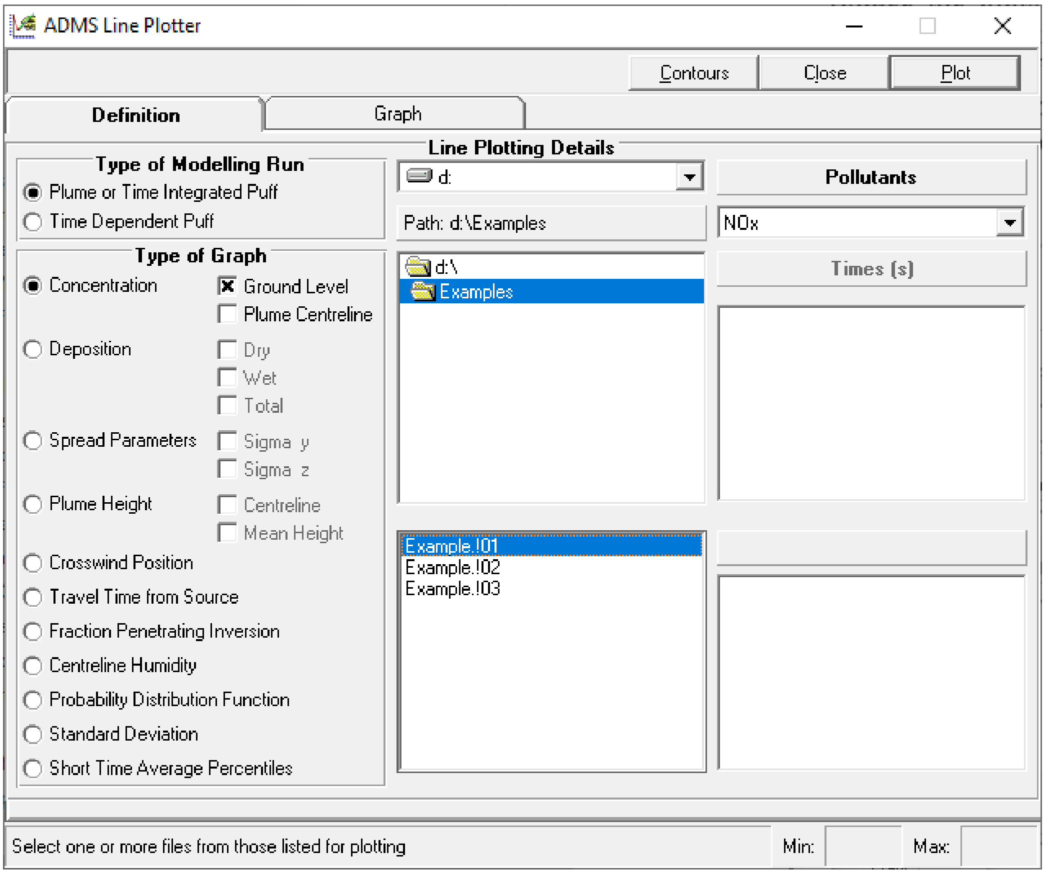


Figure 6.6 – The **ADMS Line Plotter** utility, **Definition** screen.

6.3.1 Main interface

The utility is composed of two screens: the **Definition** screen to select the data to plot, and the **Graph** screen to display and customise the plot. The **Plot** button plots the selected data. The **Close** button closes the utility. The **Contours** button opens the **2-D Output Plotter** utility.

To use the **ADMS Line Plotter**, proceed as follows:

Step 1 Select the required output from the **Definition** screen.

In the **Type of Modelling Run** box, choose the **Plume or Time Integrated Puff** option (the **Time Dependent Puff** option is not applicable to ADMS-Screen).

Step 2 Select the appropriate folder and click on the file containing the data to plot.

Up to ten output files from the list displayed in the screen can be plotted at the same time. Use the ***SHIFT*** *and* ***CTRL*** *keys to select which files to plot.*

Step 3 In the **Type of Graph** area, choose the variable to plot (see further).

More than one variable can be plotted at the same time.

Step 4 Click on the **Plot** button. The screen switches to the **Graph** screen where the data are plotted (see **Figure 6.7**).

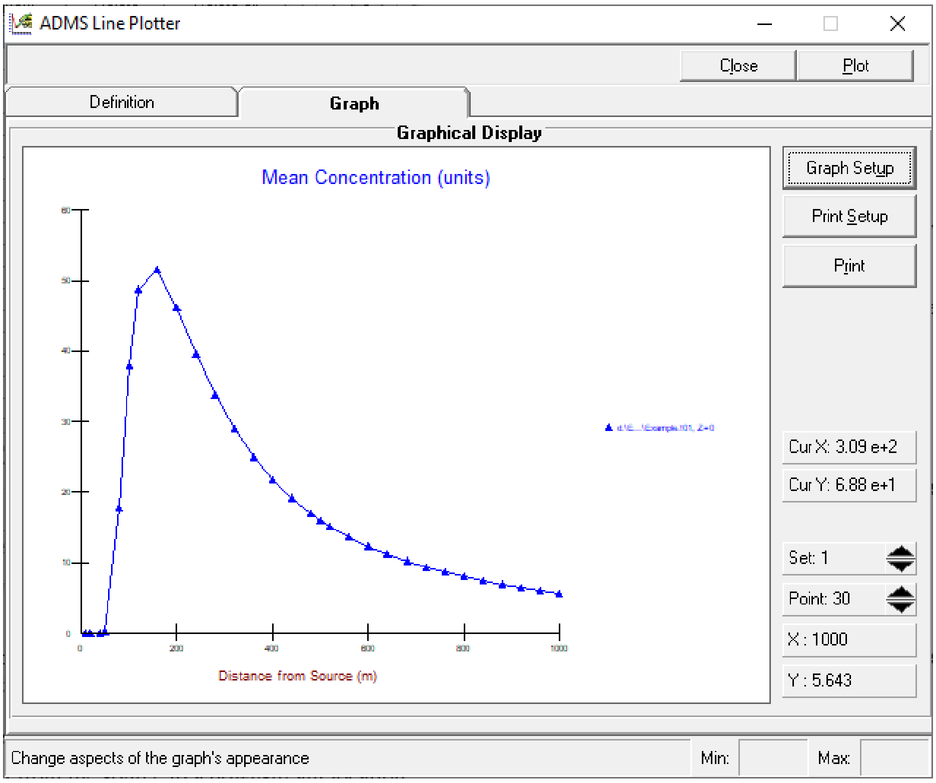


Figure 6.7 – The **ADMS Line Plotter** utility, **Graph** screen. Example of plot.

Types of graph

This section lists all the possible variables that can plotted that are relevant to ADMS-Screen.

1. **Concentration** (**Ground Level**): ground-level concentration beneath the plume centreline.

   Concentration (**Plume Centreline**): plume centreline concentration.

If there is an inversion at the top of the boundary layer that splits the plume in two, the plume centreline concentration is for the part of the plume below the inversion. When the **Buildings** option is selected, the centreline concentration of the (idealised un-split) elevated plume is given.

2. **Spread Parameters** (**Sigma y**): lateral plume spread

   Spread Parameters (**Sigma z**): vertical plume spread

   If there is an inversion at the top of the boundary layer that splits the plume in two, this output is for the part of the plume below the inversion. When buildings are also modelled these outputs apply to the (idealised un-split) elevated plume only.

3. **Plume Height** (**Centreline**): height of the plume centreline,

   Plume Height (**Mean Height**): mean height of the plume.

   If there is an inversion at the top of the boundary layer that splits the plume in two, the output is for the part of the plume below the inversion. If the **Buildings** option is selected, centreline and mean plume heights are given for the (idealised un-split) elevated plume only.

4. **Travel Time from Source**: time taken for plume material to travel from the source to a downstream location.

5. **Fraction Penetrating Inversion**: fraction of the plume that has penetrated above the top of the boundary layer.

6.3.2 Graph customisation

The appearance of the plot can be altered by clicking on the **Graph Setup** button available on the **Graph** screen (see **Figure 6.7**). It brings up the **Graph Design** dialogue box shown in **Figure 6.8**.

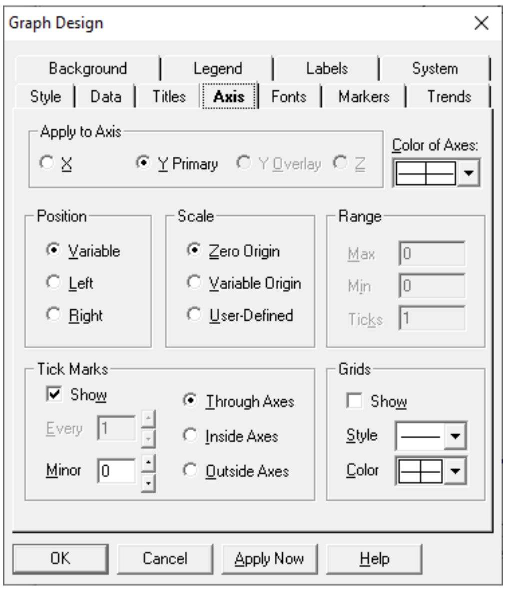


Figure 6.8 − The **Graph Design** box of the **ADMS Line Plotter** utility.

The **Graph Design** dialogue box has 11 options, the purpose of which can be briefly summarised as follows.

1. **Background**: allows the user to alter the background colour of the graph and the style of borders drawn around titles, the legend and the graph.
2. **Legend**: allows the user to select the legend text, size and position.
3. **Labels**: allows the user to turn axis labels and data point labels on and off, and change their format.
4. **System**: allows the user to print a graph and save a graph (data and/or graph layout) to file.
5. **Style**: allows the user to select how the data are to be displayed on the graph (e.g. just points or with lines joining the points), and change the scale of the axes to a log scale.
6. **Data**: allows the user to add or remove data points and control the range of data points plotted.
7. **Titles**: allows the user to write/edit titles and change the orientation of titles. The limit of 80 characters in the title is set by the graphics software.
8. **Axis**: allows the user to alter the minimum/maximum values of axes and the number of ticks. To do this, choose the axis in the **Apply to Axis** box. Click on **User-Defined** in the **Scale** box and enter the appropriate minimum/maximum values and number of ticks in the **Range** box. Click on **Apply Now**. If the graph is correct, click on **OK**. Labels and their orientation are set on the **Labels** screen.
9. **Fonts**: allows the user to set the font of the graph title, axes labels and legends.
10. **Markers**: allows the user to alter the symbol used in the graph to denote the data points, change the size and colour of these symbols, and adjust the colour and thickness of the line and whether it is dashed or solid.
11. **Trends**: allows the user to add limit lines, statistical lines and fit a curve to data points.

6.4 Log files

The reporting files produced during a model or verification run for the currently open *.apl* file can be viewed from the ADMS-Screen interface at any time by selecting **Log files** from the **Results** menu. This will bring up the file verification results screen, as shown in **Figure 6.9**.

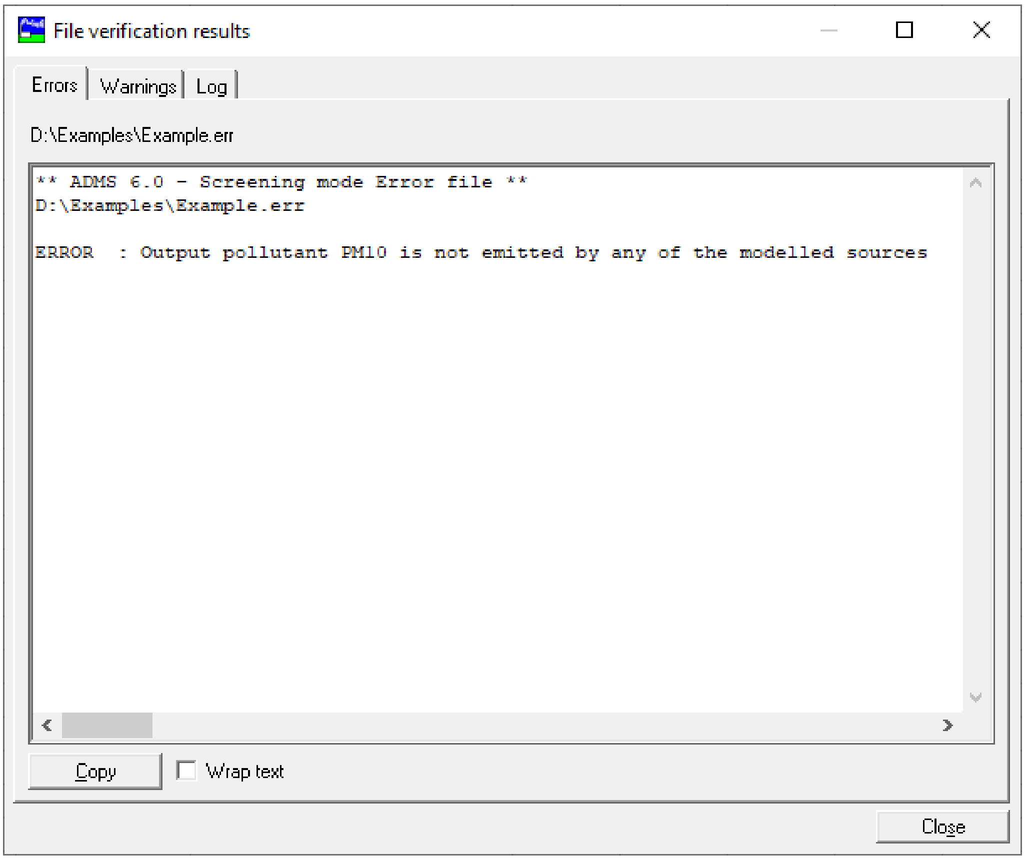


Figure 6.9 – The **File verification results** screen.

This window shows each of the different reporting files in separate tabs (these files are described in more detail in Section 6.1.1). If a file does not exist for the current *.apl* (for instance, if there were no errors found in verification) then the corresponding tab will not appear.

On each screen the horizontal and vertical scroll bars can be used to view the information outside the current visible area. Alternatively, checking the **Wrap text** box will cause the text in each tab to be wrapped (each line broken to fit horizontally in the window) so that only vertical scrolling is required. The **Copy** button can be used to copy all of the text in the current screen to the clipboard.

6.5 Viewing numerical data

The numerical output files created by ADMS-Screen are mainly comma-separated text files. Input and output files can be accessed from the ADMS-Screen interface (**View** buttons for the input files, **Results, Numerical output** menu option for the output files), and viewed in WordPad, Notepad, Microsoft Excel or some other application of the user's choice. The application used to view files is set in the **Preferences** menu (see Section 6.5.1).

An alternative way of opening the output files in Microsoft Excel is outlined in Section 6.5.3.

6.5.1 Choosing application to view output

To change the preferred viewing application for input data and output files, select **File**, **Preferences**, **Viewing options** from the menu bar of the ADMS-Screen interface. This will bring up the **File Viewing Preferences** screen shown in **Figure 6.10**.

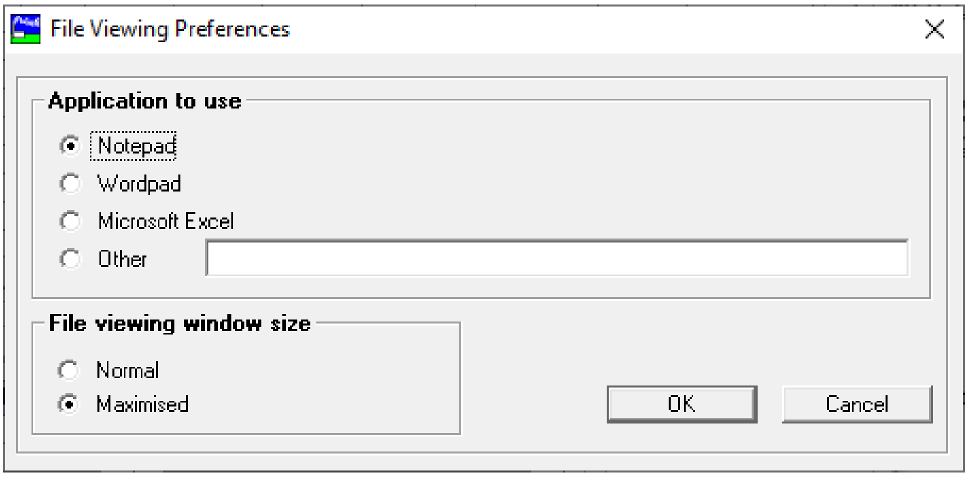


Figure 6.10 – The **File Viewing Preferences** window.

Application to use allows the user to select which application to use to **View** files. If an application other than Notepad, WordPad or Microsoft Excel is to be used, then select **Other** and enter the path of the application.

File viewing window size defines the size of the viewing window when it is opened. Choices are either **Normal** (size of the last used window) or **Maximised** (full screen).

6.5.2 Viewing output from the ADMS-Screen interface

The output files associated with the *.apl* file that is currently open in the interface can be viewed using the **Results, Numerical output** menu command of the interface. A screen will appear showing all of the output files for the current *.apl* file. After selecting a file and clicking **Open**, the file will be opened with the application selected in the **File Viewing Preferences**, as described in Section 6.5.1.

If the file is being opened in Microsoft Excel, it will automatically be opened as a comma-separated file.

6.5.3 Use of Microsoft Excel to view numerical output

The numerical output files can be opened using Microsoft Excel without using the ADMS-Screen interface, proceeding as follows. These instructions relate to Microsoft Excel 2016.

Step 1 Start Microsoft Excel.

Step 2 Select **File > Open** from the ribbon, and browse through the directories to locate the relevant file, making sure that **All files (*.*)** is selected in the lower right drop-down menu. You can also type, e.g. '*.gst' in the **File name** box and press Enter to see just those files that end with the extension *.gst* in the current directory.

Step 3 Click on the file and then click **Open**. This starts the Microsoft Excel **Text Import Wizard** shown in **Figure 6.11**.

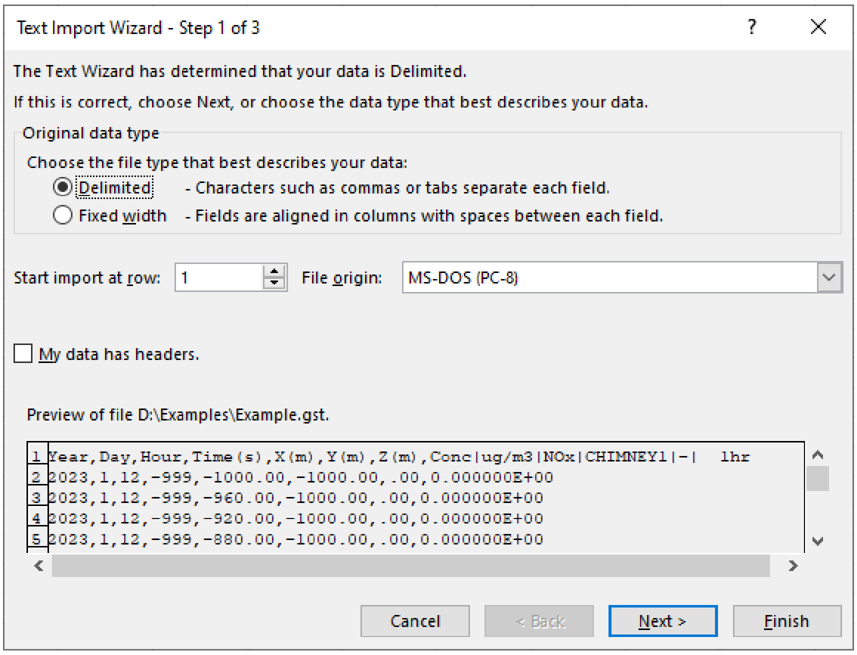


Figure 6.11 − Step 1 of the Microsoft Excel **Text Import Wizard**.

Step 4 ADMS-Screen output files are comma-delimited so they can be imported easily into many standard packages.

In **Figure 6.11**, select the **Delimited** option and click on **Next >** to move to the next step, shown in **Figure 6.12**.

Double-click on the option to select it and to move directly to the next step.

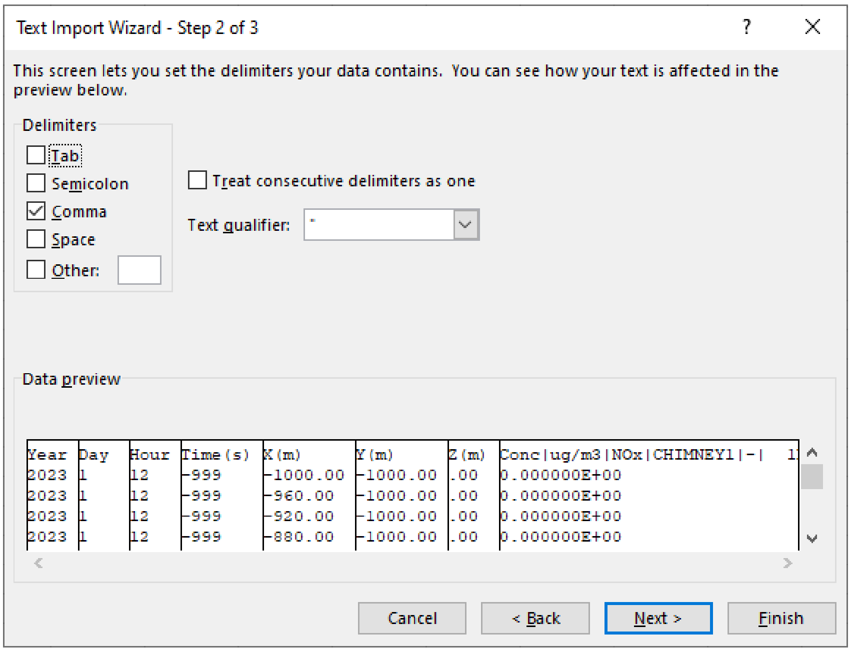


Figure 6.12 − Step 2 of the Microsoft Excel **Text Import Wizard**.

Step 5 In the **Delimiters** box, select only the **Comma** check box and click on **Next >** to move to the last step, shown in **Figure 6.13**.

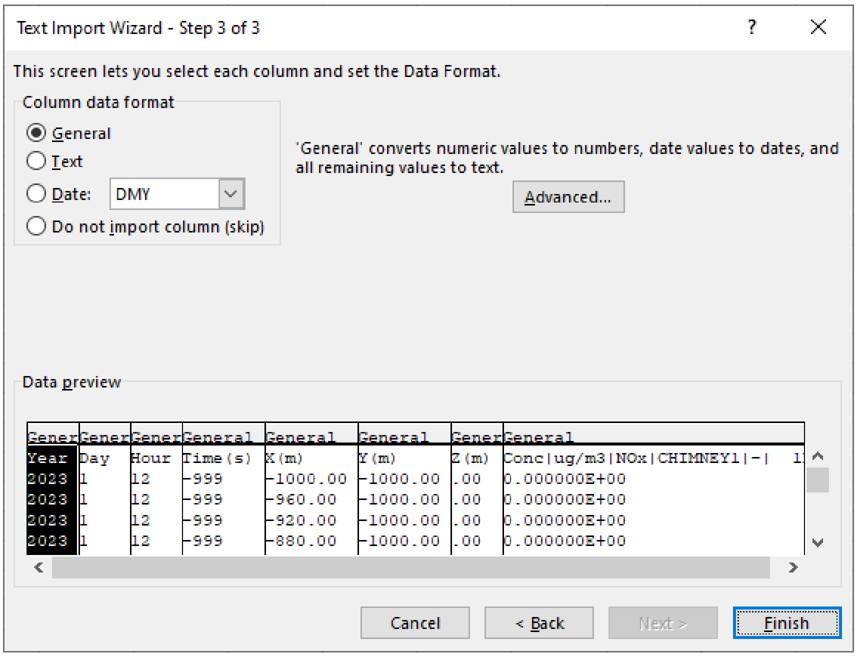
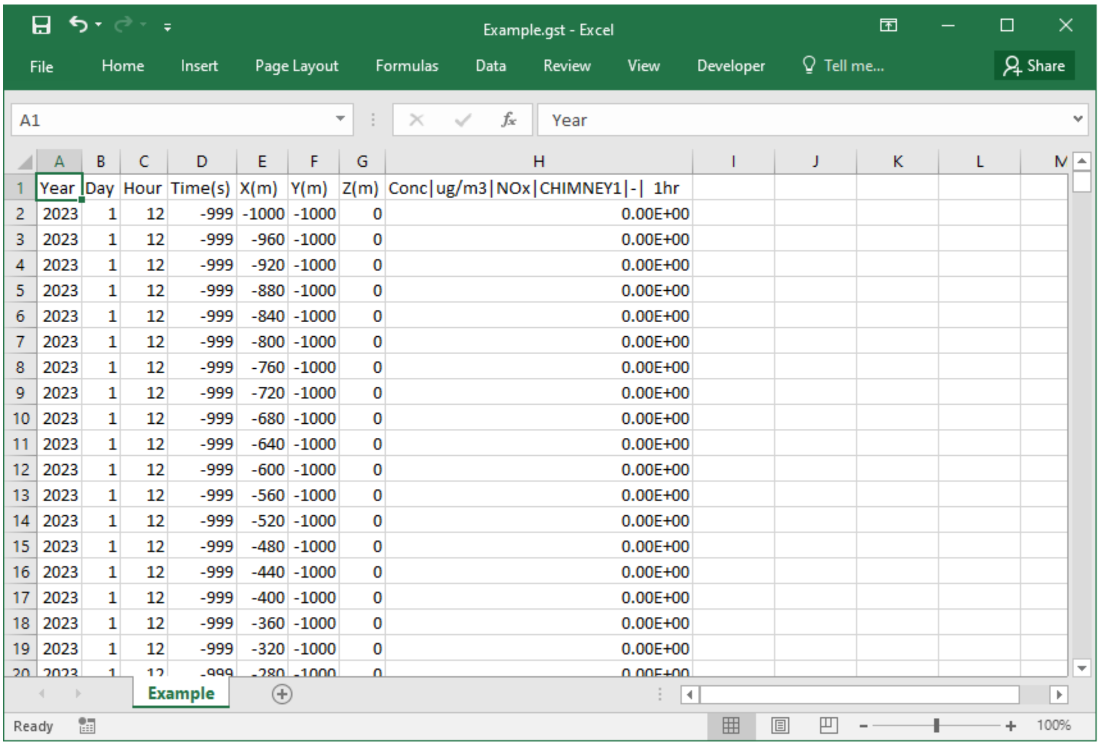


Figure 6.13 − Step 3 of the Microsoft Excel **Text Import Wizard**.

Step 6 In the **Data Preview** box, ensure that the file has been properly separated and click on **Finish** to import the data.

Imported data in Microsoft Excel are shown in **Figure 6.14**.

If the column headings are not visible because the columns are too narrow, select all the columns containing data and use the **Format** button in the **Cells** section of the **Home** tab and select **Auto Fit Selection** to increase the column widths to fit the longest entry in each column.



	A	B	C	D	E	F	G	H
1	Year	Day	Hour	Time(s)	X(m)	Y(m)	Z(m)	Conc|ug/m3|NOx|CHIMNEY1|-| 1hr
2	2023	1	12	-999	-1000	-1000	0	0.00E+00
3	2023	1	12	-999	-960	-1000	0	0.00E+00
4	2023	1	12	-999	-920	-1000	0	0.00E+00
5	2023	1	12	-999	-880	-1000	0	0.00E+00
6	2023	1	12	-999	-840	-1000	0	0.00E+00
7	2023	1	12	-999	-800	-1000	0	0.00E+00
8	2023	1	12	-999	-760	-1000	0	0.00E+00
9	2023	1	12	-999	-720	-1000	0	0.00E+00
10	2023	1	12	-999	-680	-1000	0	0.00E+00
11	2023	1	12	-999	-640	-1000	0	0.00E+00
12	2023	1	12	-999	-600	-1000	0	0.00E+00
13	2023	1	12	-999	-560	-1000	0	0.00E+00
14	2023	1	12	-999	-520	-1000	0	0.00E+00
15	2023	1	12	-999	-480	-1000	0	0.00E+00
16	2023	1	12	-999	-440	-1000	0	0.00E+00
17	2023	1	12	-999	-400	-1000	0	0.00E+00
18	2023	1	12	-999	-360	-1000	0	0.00E+00
19	2023	1	12	-999	-320	-1000	0	0.00E+00

Figure 6.14 – ADMS-Screen output data imported into Microsoft Excel.

6.5.4 Use of Microsoft Excel to create a time series graph

Microsoft Excel can also be used to produce a time series graph of short-term concentration, etc., at each of the specified output points. To produce such a graph, follow these steps, again these instructions relate to Microsoft Excel 2016:

Step 1 Open a *.pst* output file in Microsoft Excel as described in Section 6.5.3.

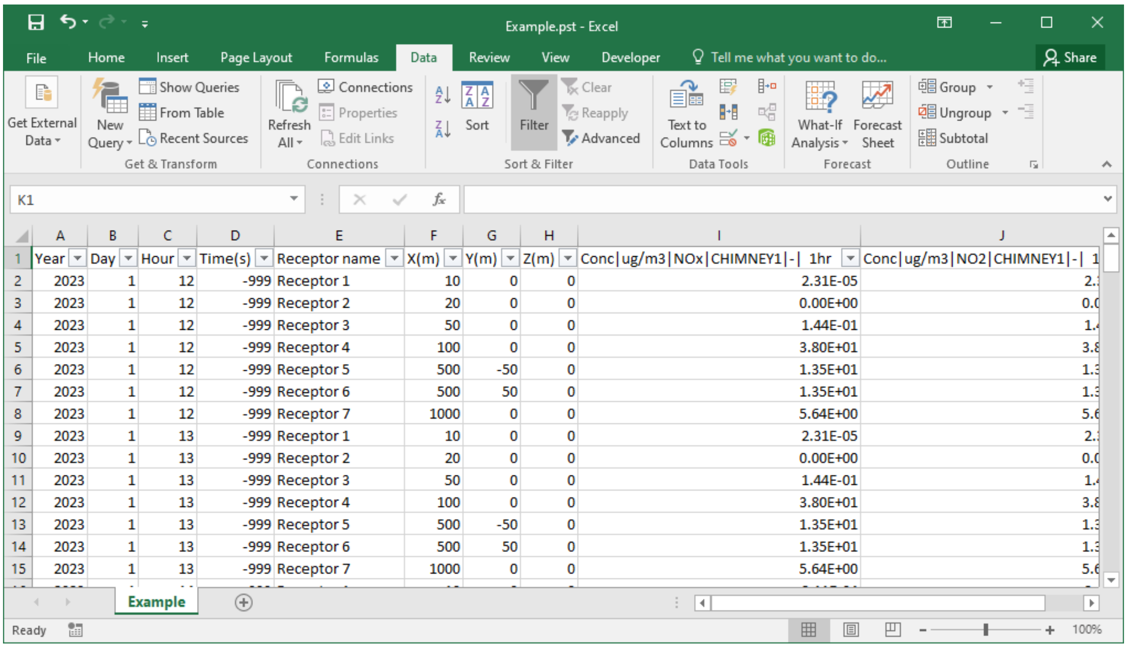
Step 2 Select all columns containing data (e.g. columns A:J in **Figure 6.15**) and choose **Filter** from the **Sort & Filter** section of the **Data** tab.

Filters are activated and represented by the arrow box in each of the heading cells.

Step 3 Filter the data as required (e.g. all values for a specific receptor) by clicking on the appropriate arrows. For example, the 'Receptor 3' value as shown in **Figure 6.16**.

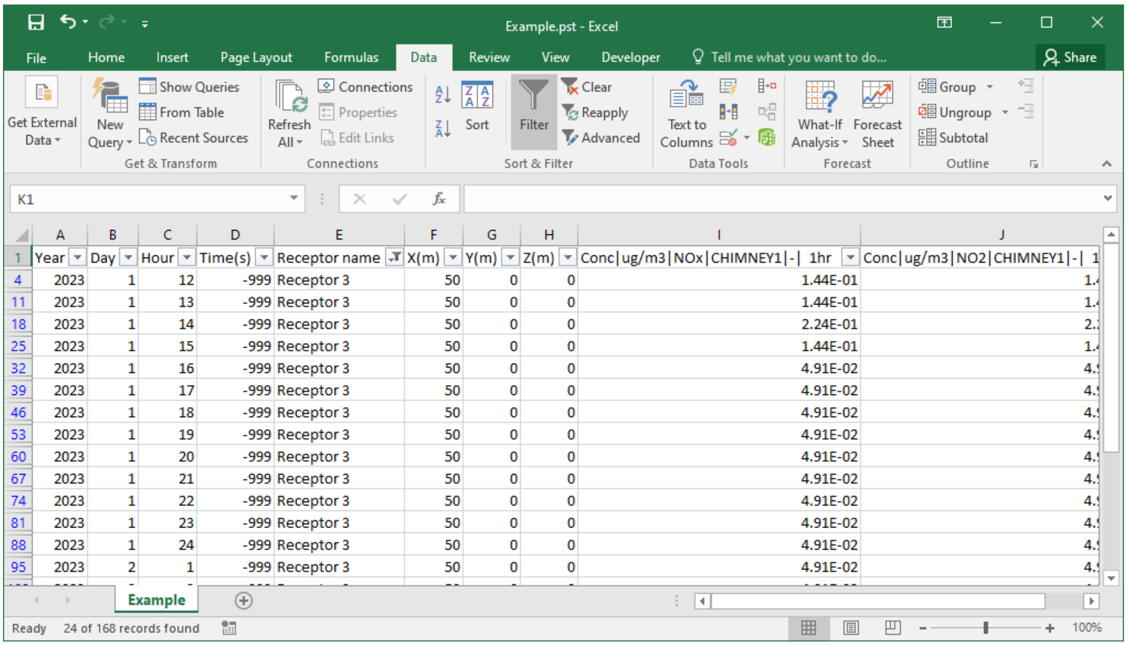
Step 4 Select the columns to be plotted by clicking on these columns while holding down the Control key. Then choose the chart type you want from the **Charts** section of the **Insert** tab.

Step 5 The chart will appear and can be customized by first selecting the chart and then using the subtabs that appear under the **Chart Tools** tab.



	Year	Day	Hour	Time(s)	Receptor name	X(m)	Y(m)	Z(m)	Conc|ug/m3|NOx|CHIMNEY1|-| 1hr	Conc|ug/m3|NO2|CHIMNEY1|-| 1
2	2023	1	12	-999	Receptor 1	10	0	0	2.31E-05	2.
3	2023	1	12	-999	Receptor 2	20	0	0	0.00E+00	0.0
4	2023	1	12	-999	Receptor 3	50	0	0	1.44E-01	1.
5	2023	1	12	-999	Receptor 4	100	0	0	3.80E+01	3.8
6	2023	1	12	-999	Receptor 5	500	-50	0	1.35E+01	1.3
7	2023	1	12	-999	Receptor 6	500	50	0	1.35E+01	1.3
8	2023	1	12	-999	Receptor 7	1000	0	0	5.64E+00	5.6
9	2023	1	13	-999	Receptor 1	10	0	0	2.31E-05	2.
10	2023	1	13	-999	Receptor 2	20	0	0	0.00E+00	0.0
11	2023	1	13	-999	Receptor 3	50	0	0	1.44E-01	1.
12	2023	1	13	-999	Receptor 4	100	0	0	3.80E+01	3.8
13	2023	1	13	-999	Receptor 5	500	-50	0	1.35E+01	1.3
14	2023	1	13	-999	Receptor 6	500	50	0	1.35E+01	1.3
15	2023	1	13	-999	Receptor 7	1000	0	0	5.64E+00	5.6

Figure 6.15 − Filtering ADMS-Screen output files in Excel.



	Year	Day	Hour	Time(s)	Receptor name	X(m)	Y(m)	Z(m)	Conc|ug/m3|NOx|CHIMNEY1|-| 1hr	Conc|ug/m3|NO2|CHIMNEY1|-| 1
4	2023	1	12	-999	Receptor 3	50	0	0	1.44E-01	1.
11	2023	1	13	-999	Receptor 3	50	0	0	1.44E-01	1.
18	2023	1	14	-999	Receptor 3	50	0	0	2.24E-01	2.
25	2023	1	15	-999	Receptor 3	50	0	0	1.44E-01	1.
32	2023	1	16	-999	Receptor 3	50	0	0	4.91E-02	4.
39	2023	1	17	-999	Receptor 3	50	0	0	4.91E-02	4.
46	2023	1	18	-999	Receptor 3	50	0	0	4.91E-02	4.
53	2023	1	19	-999	Receptor 3	50	0	0	4.91E-02	4.
60	2023	1	20	-999	Receptor 3	50	0	0	4.91E-02	4.
67	2023	1	21	-999	Receptor 3	50	0	0	4.91E-02	4.
74	2023	1	22	-999	Receptor 3	50	0	0	4.91E-02	4.
81	2023	1	23	-999	Receptor 3	50	0	0	4.91E-02	4.
88	2023	1	24	-999	Receptor 3	50	0	0	4.91E-02	4.
95	2023	2	1	-999	Receptor 3	50	0	0	4.91E-02	4.

Ready 24 of 168 records found

Figure 6.16 − Filtering ADMS-Screen output files in Excel, filter on the receptor name.

SECTION 7 Utilities

This section describes the **Mapper** and the utilities listed in the menu **Utilities** of the ADMS-Screen interface (shown in **Figure 7.1**), i.e.:

1. **View a wind rose**
2. **Visualise input in Surfer...**
3. **Create/Run batch file**
4. **Convert met. data**
5. **Create ASP grid**
6. **Create import templates**

These utilities are divided into visualisation tools (numbers 1 and 2), input data processing tools (numbers 3 and 4; number 5 is not applicable to ADMS-Screen) and an option for creating template files for **Import** (6, refer to Section 5.1.6 for more details). There are also options to **Start Excel** and **Start Surfer** which launch Microsoft Excel and the Surfer application respectively if these programs are installed. Help and tips on the use of Surfer are provided in Appendix D.

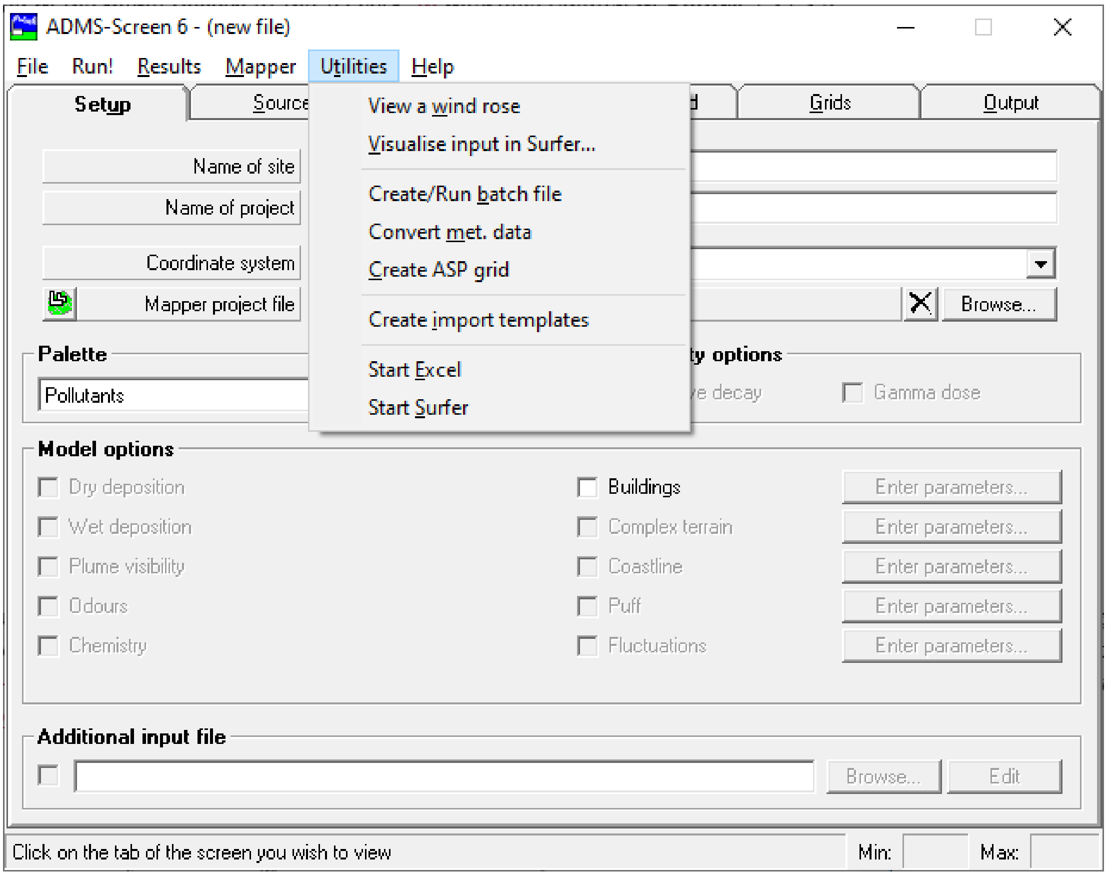


Figure 7.1 – The **Utilities** menu.

7.1 Mapper

The **Mapper** is an integrated mapping tool for displaying and editing source data, building and receptor locations and viewing results. It is launched via the **Mapper** menu item or the button on the **Setup** screen and illustrated in **Figure 7.2**. Please refer to the *Mapper User Guide* for full details on using the **Mapper** which can be accessed from the **Help** menu of the **Mapper**.

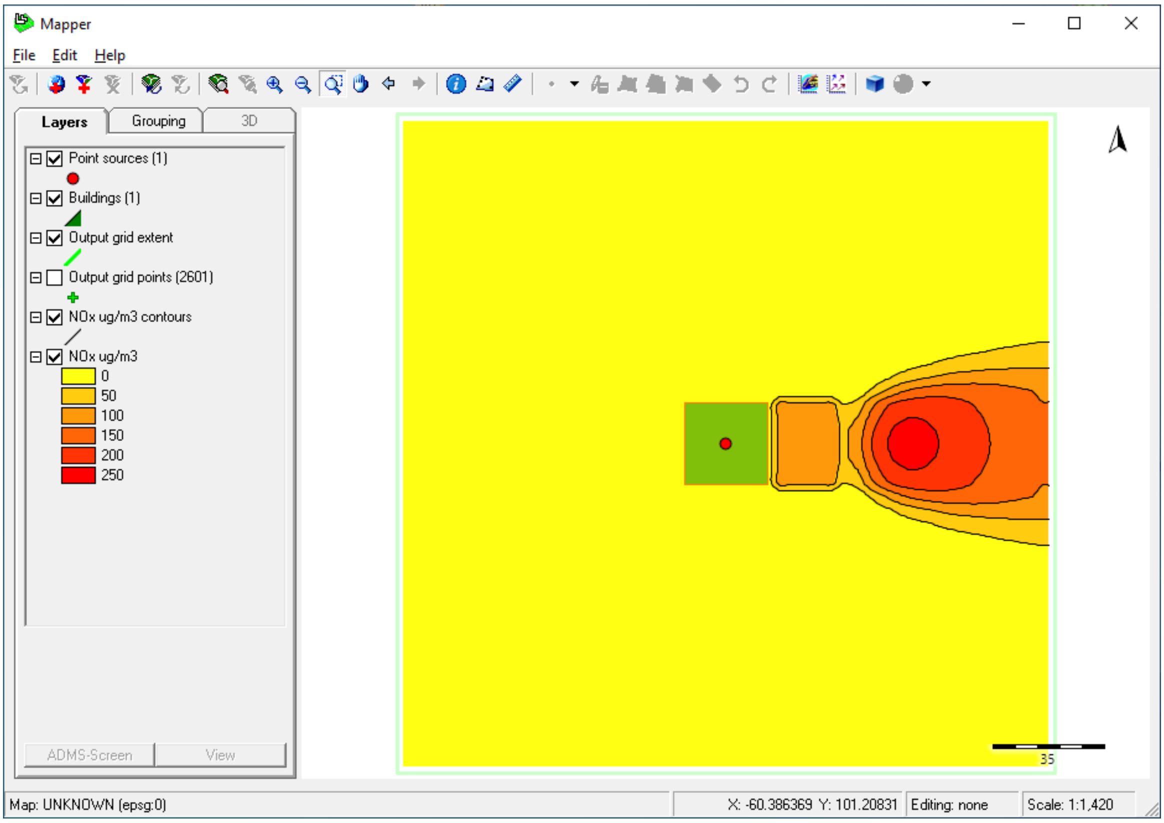


Figure 7.2 – The **Mapper** interface.

Some of the useful features in the **Mapper** allow the user to:

- create a new source by drawing;
- create a building and receptor points by drawing;
- edit geometry of existing source, building and receptor points;
- create contour plots;
- export source or building in a variety of formats, including shape files, MapInfo MIF files and KML files;
- automate the generation of comma-separated variable files, for direct import into ADMS-Screen, from source data contained within non-ADMS layers, e.g. shape files;
- create images for inclusion in reports showing contour plots, positions of source and building; and
- view map image tiles, shape files, MapInfo files, AutoCAD DXF files, etc.

7.2 Viewing a wind rose

The **Wind rose viewer** utility allows the data in a meteorological data file (*.met*) to be visualised graphically. The visualisations can be viewed on the screen, printed, copied to another Windows application or exported to a file. An example of a copied image is shown below in **Figure 7.3**.

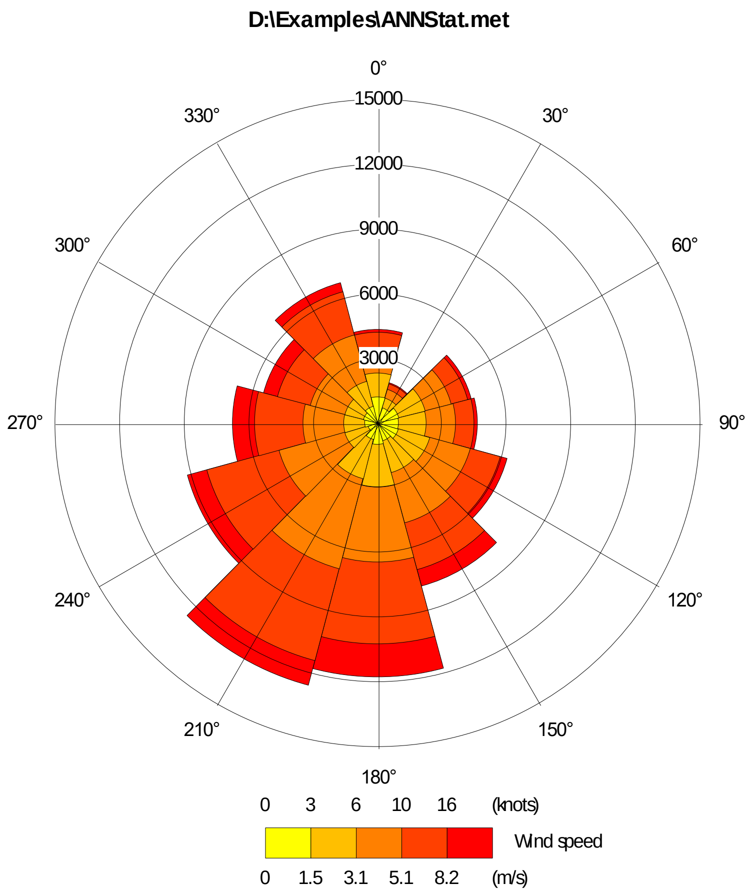


Figure 7.3 – Example of a wind rose produced with the ADMS-Screen **Wind rose viewer** utility.

7.2.1 Categories for the data

To produce these visualisations, the data in the meteorological file is divided into categories by wind speed and wind direction. This information is displayed in a polar plot, in which the angle of an element represents the wind direction and the radial distance from the centre represents the frequency of occurrence.

For statistical meteorological data, the frequency is taken from the data in the file. For sequential meteorological data, the frequency of each line is taken to be 1.

The wind speed categories are those used by the UK Met Office in their statistical meteorological data, namely 0-3 knots, 3-6 knots, 6-10 knots, 10-16 knots and 16 knots or above. Meteorological lines with wind speeds of less than 0.01 m/s are not included in the plot.

7.2.2 Using the wind rose utility

The wind rose utility is accessed from the **Utilities, View a wind rose** command or from the **Wind rose** button on the **Meteorology** screen and is shown in **Figure 7.4**.

*If the **Wind rose** button on the **Meteorology** screen is used the meteorological data file currently selected in the interface will automatically be loaded into the **Wind rose viewer**. Launching from the **Wind rose** button will allow the selected sector size and Met. data subset to be taken into account.*

Opening a meteorological file (.met)

To open a meteorological file, go to the **File, Open...** command and browse for the *.met* file.

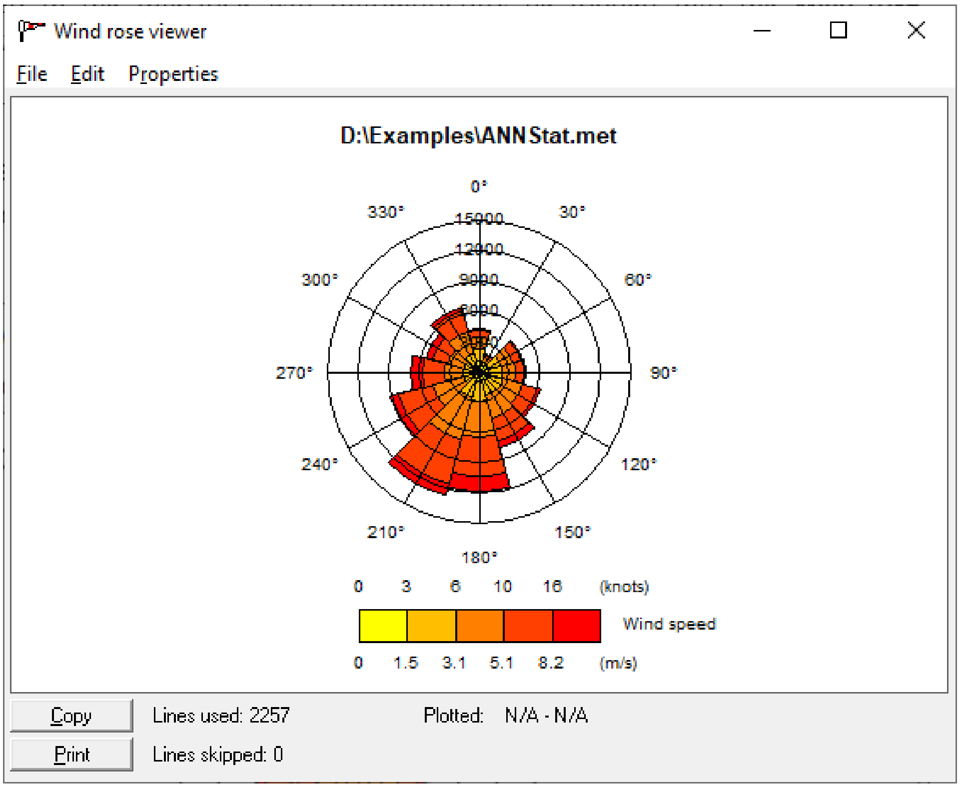


Figure 7.4 – Main screen of the **Wind rose viewer** Utility.

Customising the appearance of the wind rose

The appearance of the wind rose can be altered using the various options from the **Properties** menu:

- The colours used in the wind rose can be set by selecting the **Colour for highest wind speed...** and **Colour for lowest wind speed...** options.
- The title can be shown or removed by checking or clearing **Show Title**. The title can be altered by choosing **Set Title...**.
- The fonts used in the wind rose display can be altered as follows: choose **Label Font...** to alter the font for the wind speeds and angles, and choose **Title Font** to alter the font for the title.

- There are several different visualisation styles for the wind rose. These can be selected as follows: choose **Arc segments** to display each wind sector as a pie slice, choose **Polygon** to join points along neighbouring wind sector centrelines to form the sides of a polygon, or choose **Triangles** to display each wind sector as a triangle.
- The angle interval into which the wind speeds are "binned" for display can be altered by choosing one of **10° intervals**, **22.5° intervals** or **30° intervals**. Note that changing the binning interval can take several seconds.

Printing the wind rose

To print the wind rose, click the **Print** button or choose **File, Print** from the menu. To use a different printer or to change the settings of the current printer, choose **Print Setup...** from the menu. The wind rose will occupy a complete printed page.

Copying the wind rose to the clipboard

The wind rose can be copied to the clipboard by clicking the **Copy** button or by choosing **Edit, Copy** from the menu. It can then be pasted into another Windows application, such as Microsoft Word.

Exporting the wind rose to a file

The wind rose image can be exported as an enhanced metafile file (*.emf*) by choosing **File**, **Export Picture...** from the menu. This file may then be imported into other Windows applications, such as Microsoft Word. The imported image may be resized without reducing the resolution quality.

7.3 Visualising input data in Surfer

ADMS-Screen includes an alternative visualisation utility to the Mapper using Surfer, which is accessed from the **Utilities, Visualise Input in Surfer...** menu (as illustrated in **Figure 7.5**).

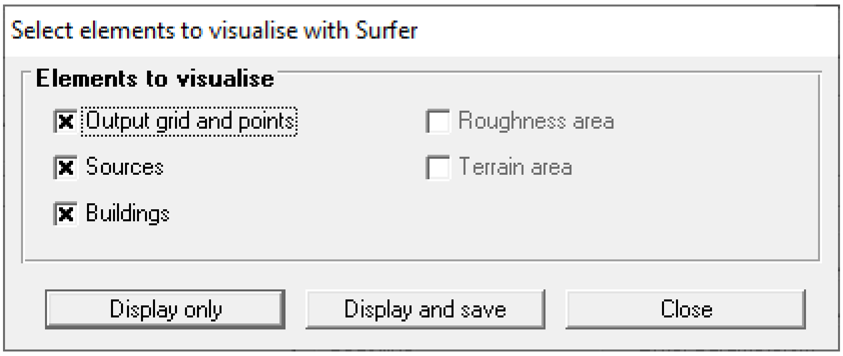


Figure 7.5 – Dialogue box to select the elements to visualise.

This utility allows the user to visualise the positions of various features and their relation to one another. Like with the Mapper, this provides a very useful mechanism for checking the model setup before clicking on the **Run!** command.

The output is produced in Surfer, can be saved as a Surfer file (*.srf*) and imported into report documents. These files can also be combined with ADMS-Screen output contour plots to create a Surfer overlay.

The features that can be visualised are:

- the output grid as specified in the **Grids** tab,
- specified points as specified in the **Grids** tab,
- source location as specified in the **Source** tab,
- building position, dimensions and orientations as specified in the **Buildings** screen.

Only the features *currently defined in the interface (or loaded* .apl *file)* can be visualised. By default, all the available features are selected. You can narrow the selection by unchecking the box of the features you do not want to visualise.

If it appears after the first visualisation that, say, a source position has been specified incorrectly, then return to the main ADMS-Screen interface, make the appropriate changes and then click on **Utilities, Visualise input in Surfer...** again until the input data are as required.

7.3.1 Display and/or save the visualisation

The user can choose **Display only** to make a quick check of the data at any stage during the creation of an *.apl* file or **Display and Save** to save the output as a Surfer file (*.srf*).

Clicking **Display only** displays the visualisation in Surfer. This visualisation can be modified and saved afterwards in Surfer if needed.

On clicking **Display and save**, the user is prompted for a Surfer file name (*.srf*). The visualisation will then be created in Surfer and saved using the file name given. A number of so-called “post files” (*.dat*) will also be created, based on the Surfer file name provided.

For guidance on customising the Surfer visualisation, please refer to Appendix D.

7.3.2 Layout of visualised features

A legend is provided as a key for all the elements in the visualisation. This legend should appear below the map. If the default paper size in Surfer is not A4, the legend may be incorrectly positioned. The mouse can be used to select the legend and move it to a new position.

Output locations (grid and specified points)

Regular and variable grids are shown on the visualisation as a grid of green lines with the X and Y coordinates shown along each axis.

If specified points are also chosen as output, these are shown as green crosses with their labels plotted to the right. An example of a regular grid with four specified points is shown in **Figure 7.6**.

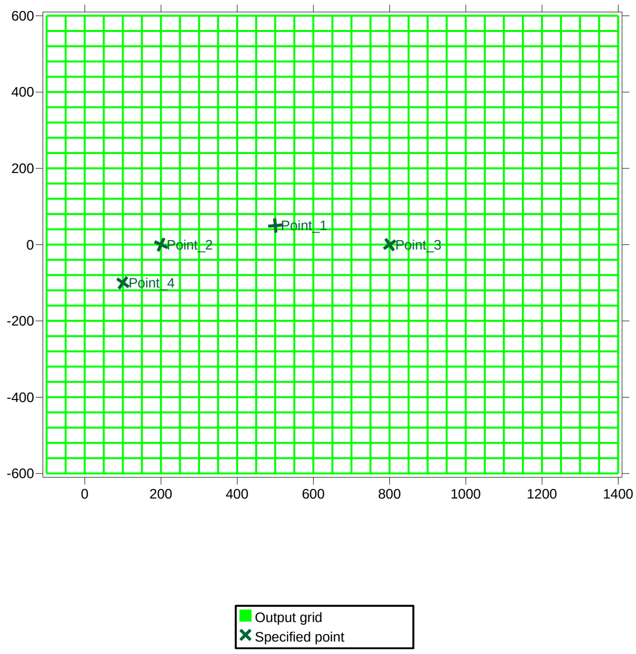


Figure 7.6 – A regular output grid and four specified points.

Sources

A point source is shown as a five-pointed red star, labelled to the right.

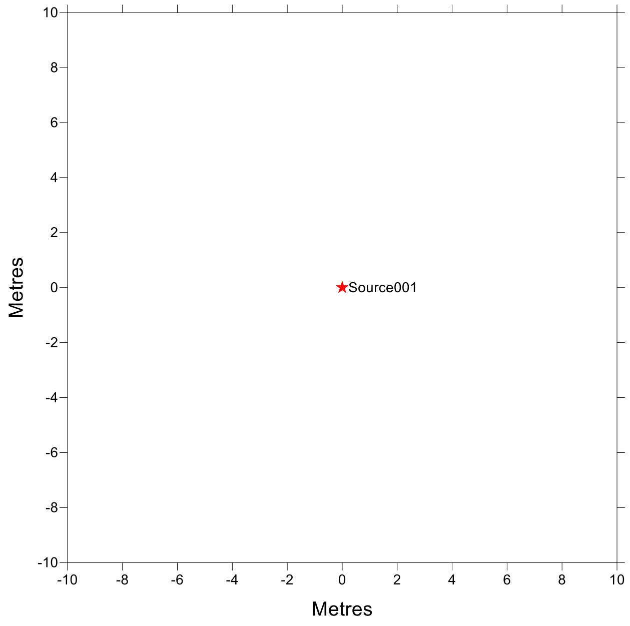


Figure 7.7 – A point source.

Buildings

A building is represented as a grey area labelled at the centre with the name assigned to it in the interface. The height of the building is not indicated. This is shown in **Figure 7.8** below.

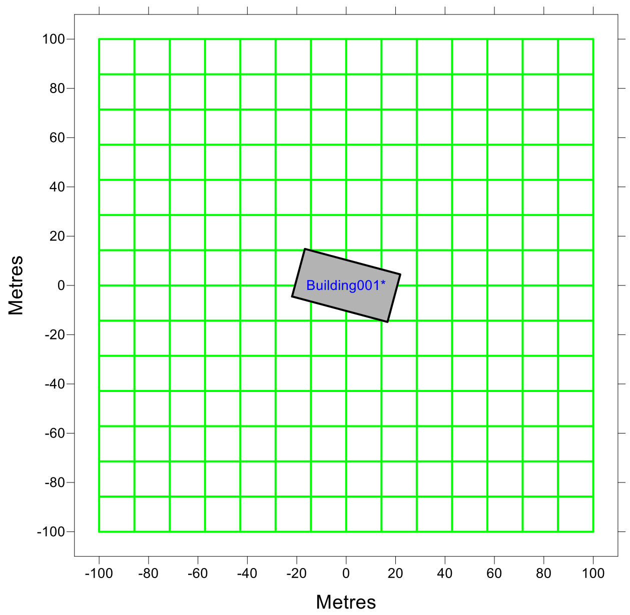


Figure 7.8 – Rectangular building.

7.4 Creating and running a batch file

It is often useful to be able to run several files consecutively, without opening each *.apl* file in the ADMS-Screen interface and using the **Run!** menu option. This can be done using a batch file. A batch file is a plain text file with the extension *.bat*, containing DOS commands.

7.4.1 Format of batch files

The most common syntax for running ADMS-Screen is:

```
<model path name> <file path name> /e2 /Screen
```

where `<model path name>` is the full path name of the ADMS-Screen executable file (*ADMSModel.exe* located in the model installation directory),

`<file path name>` is the full path name of the *.apl* file you wish to run, both enclosed in inverted commas ("),

`/e2` is an option to cancel the prompt window at the end of the model run and

`/Screen` is a command to ensure that the model runs in ADMS-Screen mode.

For example, if ADMS-Screen is installed in directory *C:\Program Files\CERC\ADMS-Screen* and the *.apl* file to run is *D:\Work\Test.apl*, the command will be:

```
"C:\Program Files\CERC\ADMS-Screen\ADMSModel.exe" "D:\Work\Test.apl" /e2 /Screen
```

Repeat this line for each *.apl* file you are running. The text in a *.bat* file is not case-sensitive. To start the model run(s), double-click on the *.bat* file in Explorer.

7.4.2 Batch File Creator utility

Batch files may also be created and run using the **Batch File Creator** utility of ADMS-Screen.

To launch it, select the **Utilities, Make/Run batch file** menu command. It opens the screen shown in **Figure 7.9**.

Figure 7.9 – **Batch File Creator** utility.

To set up and run a batch file, proceed as follows.

Step 1 Click on **Add...** and browse for the *.apl* file to be run. The path and name of the selected file is added to the **Files to be processed** box.

Repeat until all the files you wish to run are included in the list (**Figure 7.10**). Files may be removed from the list with the **Remove** button.

Multiple .apl *files can be selected together in the browse window and added. In such case, they are listed alphabetically.*

Step 2 Save the batch file by clicking on **Save**. The file is saved with the extension *.bat*.

The batch file must always be saved prior to running.

Step 3 Run the batch file immediately (**Run**) or exit the utility (**Close**).

The .apl *files are run in the listed order.*

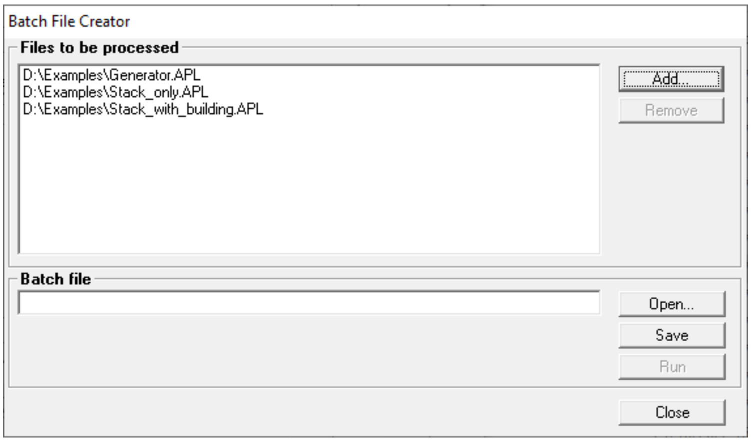


Figure 7.10 – Selection of files to be included in the batch file.

To open and edit or run a batch file which you have created earlier, click **Open** and browse for the batch file. The *.apl* files to be run will be listed in the **Files to be processed** box.

7.5 Converting meteorological data

The **Convert Met. Data** utility (shown in **Figure 7.11**) converts two types of meteorological data used in the United States into the ADMS-Screen format. The two accepted types of data are:

1. NOAA/NCDC files (*.dat*) created using the HUSWO program to extract data from a NOAA/NCDC Hourly Weather Observations archive CD.
2. Surface data files (*.sfc*) used as input files for the American AERMOD model.

In addition it is possible to incorporate upper air files with the NOAA/NCDC files, or to incorporate an upper air file into an existing ADMS-Screen format meteorological data file (*.met*). There are two accepted formats of upper air files:

1. FSL Rawisond data format from NOAA.
2. Upper air data format used as input to the American AERMET meteorological processor.

---

*The meteorological converter will **not** handle blank lines or missing data. Input data must be complete otherwise output data will be incorrect.*

Some examples of input files are supplied with ADMS -Screen as well as the corresponding meteorological output files produced. See the files *<install_path>\Examples\ex_dat.** and *<install_path>\Examples\ex_sfc.**.

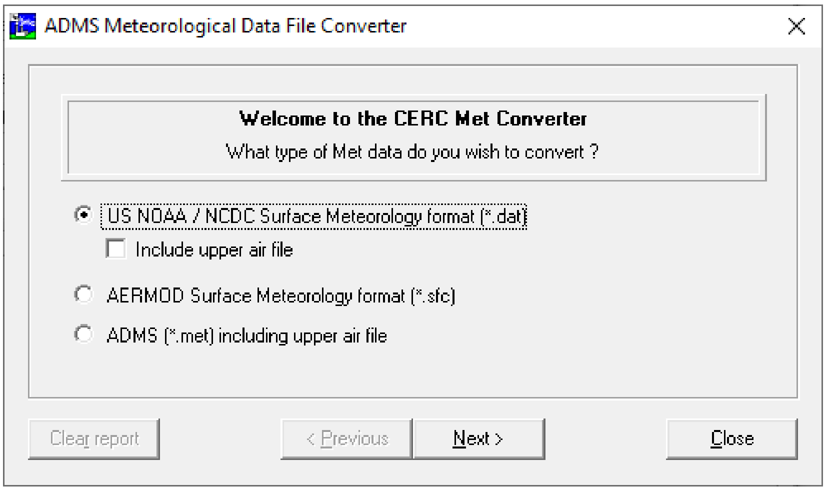


Figure 7.11 – **Convert Met. Data** utility.

7.5.1 Running the utility

To launch the utility, select the **Utilities**, **Convert Met. Data** menu command to access the screen shown in **Figure 7.11**. Use the **< Previous** and **Next >** buttons to navigate between the screens.

Step 1 Select the type of meteorological data you want to convert.

Step 2 Indicate successively the path and name of the file to convert, the upper air file (if one is being used), the meteorological output file and the report file.

By default, the output and report files are located in the same directory as the input file. They use the same filename stem with different extensions (.met *and* .rpt *respectively).*

Step 3 Once you are ready, click on **Convert** in the screen shown in **Figure 7.12**. The converted meteorological data are written to the output file (*.met*) and a report file (*.rpt*) is created with information on the conversion.

Beware that any previously existing files with the same name will be overwritten when you click on **Convert***, without warning message.*

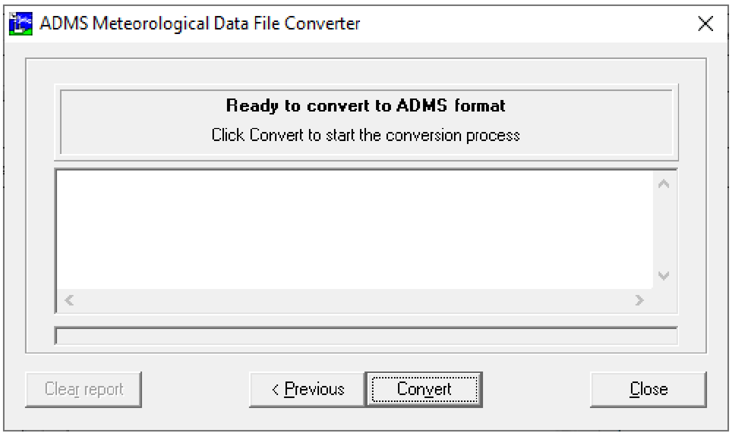


Figure 7.12 – Convert Met. Data utility, **Ready-to-convert to ADMS format** screen.

Step 4 If the upper air file supplied does not contain a longitude value then a screen to enter this will appear (as shown in **Figure 7.13**).

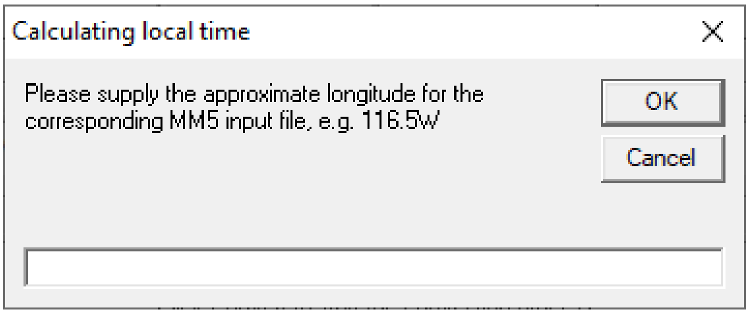


Figure 7.13 – Convert Met. Data utility, **Calculating local time** screen.

Step 5 During the conversion, data are written to the screen and to the report file (*.rpt*) (refer to section 7.5.3 for a full description). When the conversion is finished (successfully or not), a processing completed screen appears (as shown in **Figure 7.14**), click **OK** to return to the **Convert Met. Data** utility.

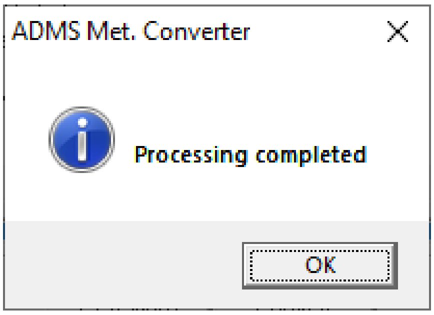


Figure 7.14 – **Convert Met. Data** utility, conversion completed screen.

Step 6 Click on **Close** to exit the utility. Alternatively, click on **< Previous** to return to earlier screens to convert another file. **Clear report** can be used to clear the report data shown on the screen.

7.5.2 Format of the output meteorological data file (.met)

Conversion from NOAA/NCDC* .dat *files

In order to convert the NOAA/NCDC *.dat* files into the ADMS-Screen format, a minimum number of variables must be present in the file and given in metric units. These are:

- the station identifier (automatically included when the *.dat* file was created),
- the time (automatically included when the *.dat* file was created),
- the sky cover,
- the dry bulb temperature,
- the relative humidity,
- the station pressure,
- the wind direction,
- the wind speed, and
- the hourly precipitation.

Additional variables present in the file will not be included in the output *.met* file produced by the conversion utility.

The header line of the output *.met* file contains the station identifier. Then follows a list of the variables included in the *.met* file. Finally the corresponding data are listed. The variables are:

- the year (`YEAR`),
- the month (`MONTH`),
- the day of the month (`DATE`),
- the Julian day (`DAY`),
- the hour of the day (`HOUR`),

- the wind speed (`U`),
- the wind direction (`PHI`),
- the cloud cover (`CL`),
- the surface temperature (`T0C`),
- the relative humidity (`RHUM`), and
- the precipitation rate (`P`).

If an upper air file is included in the conversion the buoyancy frequency above the boundary layer (`NU`) will also be included in the *.met* file. A full description of the ADMS-Screen meteorological data is given in Section 9.1.

The month and the day of the month are given for information only, and are not used by ADMS-Screen.

Conversion from AERMOD .sfc *files*

The header line of the *.sfc* file is reproduced at the start of the output *.met* file. Then follows a list of the variables included in the *.met* file. Finally the corresponding data are listed. The variables are:

- the year (`YEAR`),
- the month (`MONTH`),
- the day of the month (`DATE`),
- the Julian day (`DAY`),
- the hour of the day (`HOUR`),
- the surface heat flux (`FTHETA0`),
- the reciprocal of the Monin-Obukhov length (`RECIPLMO`),
- the surface albedo (`ALBEDO (M)`),
- the wind speed (`U`),
- the wind direction (`PHI`), and
- the surface temperature (`T0C`).

A full description of the ADMS-Screen meteorological data is given in Section 9.1.

The month and the day of the month are given for information only, and are not used by ADMS-Screen.

Conversion from ADMS .met files

The output *.met* file is a copy of the input *.met* file with the addition of the buoyancy frequency above the boundary layer (`NU`). If the input *.met* file already contains the buoyancy frequency above the boundary layer the conversion will not take place.

7.5.3 Format of the report file (.rpt)

Conversion from NOAA/NCDC* .dat *files

The report file lists the path and name of the NOAA/NCDC input file, the meteorological output file and the report file, and reproduces the station identifier from the input file.

If an upper air file is included then the path and name of the upper air file is also included in the report.

Conversion from AERMOD* .sfc *files

The report file lists the path and name of the AERMOD input file, the meteorological output file and the report file. It reproduces the header line from the input file, and provides the ranges of roughness lengths Z_0, the heights of the wind measurements Z_u and the Monin-Obukhov lengths L_{MO} of the input file. Z_0 and Z_u are not included in the ADMS-Screen *.met* files, and should be given as single representative values in the **Meteorology** tab of the ADMS-Screen interface. The range of values of L_{MO} provides useful information when using the ADMS-SCreen option to restrict the values of L_{MO} to avoid unrealistically stable boundary layers.

Conversion from ADMS .met files

The report file lists the path and name of the meteorological input file, the upper air file, the meteorological output file and the report file.

SECTION 8 Worked Examples

In order to help the user to learn how to use ADMS-Screen, a few worked examples have been set up to cover the main functions of the model. They illustrate how to set up a source scenario with a building, how to calculate long- and short-term average results under different meteorological conditions, and how to look at the calculated output in different ways.

These examples also cover the use of ADMS-Screen with the Mapper. Further details regarding using the Mapper can be found in the Mapper User Guide which can be accessed from the **Help** menu of the Mapper. The contour plots displayed in this section have been generated using the **Interpolator** gridding option, which can be selected from the **File**, **Preferences**, **Gridding option** menu item in the Mapper.

You can launch ADMS-Screen in several different ways:

- double-click on the icon for the shortcut created earlier (see Section 2.2).
- use the Windows **Start** menu and select **Programs, ADMS-Screen**;
- go to the main ADMS-Screen directory <*install_path*> and double-click on the file *adms.exe*;

It is strongly recommended to create a directory for setting up and running these examples in order to keep them separate from the examples provided in the <*install_path*>*\Examples* **directory supplied with the model.**

New users of ADMS-Screen are advised to carry out these worked examples before attempting to set up runs.

8.1 Example 1: Single point source under different meteorological conditions

The object of this example is to demonstrate how to set up and run the simplest case of a single point source problem and to look at the different types of output available from ADMS-Screen.

In particular, this example looks at emissions from a 30 m high stack. The ground-level concentration and the plume spread will be compared for seven different meteorological conditions, which correspond *approximately* to the Pasquill-Gifford stability categories A to G.

8.1.1 Setting up the run

To model a single source, proceed as follows.

Step 1 Open ADMS-Screen and click on **File**, **New** to create a new input file, i.e. a default input file or "clean sheet" in which to enter data.

Step 2 Enter a **Name of site** and **Name of project** of your choice.

These are optional but sensible titles should be entered as they help to differentiate between model runs. The titles will be written out to the log file of the model run.

As this example uses a fictitious source location, the **Coordinate system** can be left as "Unspecified regular Cartesian".

There are no building effects in this calculation. Compare your input to **Figure 8.1**. This completes input to the **Setup** screen.

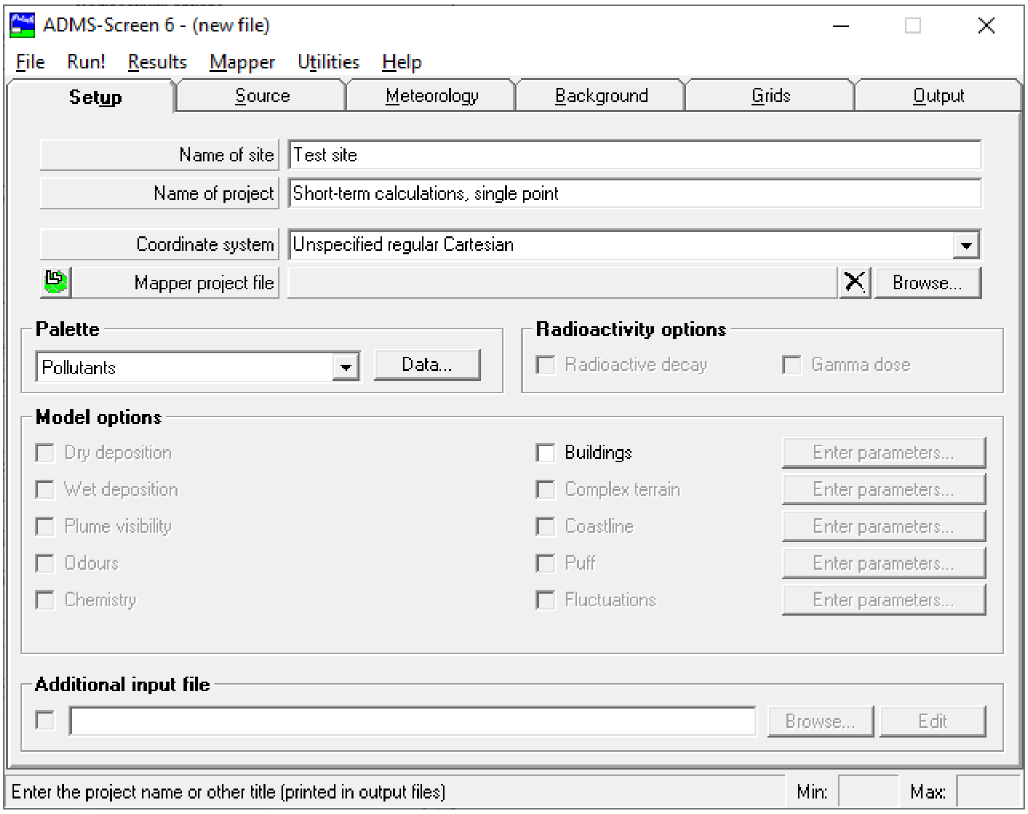


Figure 8.1 − Example 1: the **Setup** screen.

Step 3 Go to the **Source** screen. To enter a new source click on **New** to input a line of data in the table.

The default source is a point source with a height of 50 m. The scroll bar along the bottom of the table indicates that there is more information in the table that is currently out of view.

Step 4 Give the source a name such as "Boiler stack".

Step 5 Change the height of the source to 30 m and the velocity to 0 m/s.

If the velocity or volume flow rate is set to zero, then plume rise effects are ignored by the model, even if the emission temperature is greater than ambient. This is a useful mechanism to turn off plume rise. The **Source** screen should now look like **Figure 8.2**.

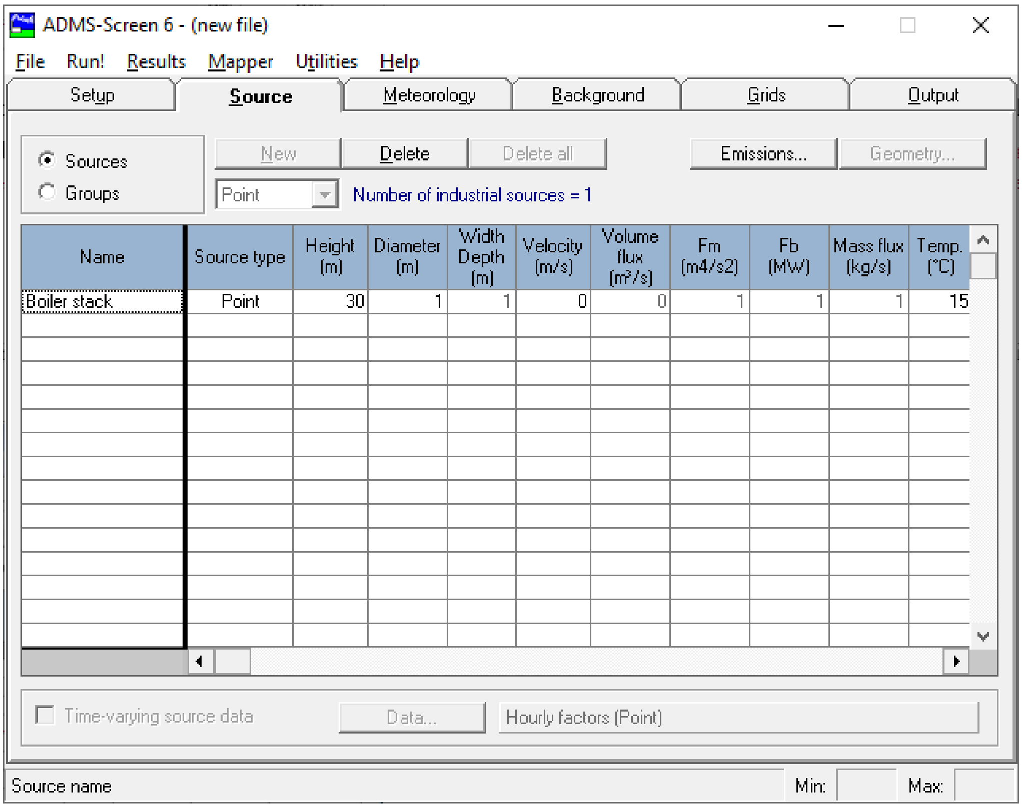


Figure 8.2 – Example 1: the **Source** screen.

The source needs to have one or more pollutants associated with it. These are entered via the **Emissions** screen. Click on the **Emissions...** button to enter the **Emissions** screen. The pollutants and mass emission rates for the source are entered here.

Step 6 Click **New** to add a new pollutant, this will add an emission for NOx by default.

Step 7 Click on the down arrow shown to the right of the word "NOx" in the **Pollutant name** cell and select SO_2 from the drop-down list (the ten pre-defined pollutants appear). Enter an emission rate of 1 g/s, so that this screen now matches that shown in **Figure 8.3**. Click **OK** to close the **Emissions** screen.

Click on the **Meteorology** tab to access the screen in which meteorological data and site data are entered. First we will enter data about the dispersion site.

Step 8 Leave the **Latitude** as 52°. Using the drop-down arrow, select a **Surface roughness** at the dispersion site for **Agricultural areas (min)**, this corresponds to a value of 0.2 m. Leave all of the other options in the **Site data** box unchanged.

Step 9 In the **Met. data** box select **Enter on Screen**. Leave the rest of the options in this box unchanged. The screen should look like **Figure 8.4**.

We now need to enter the meteorological data.

Step 10 To do this click on the **Data...** button next to the **Enter on screen** option. This will bring up the **Meteorological Data** screen.

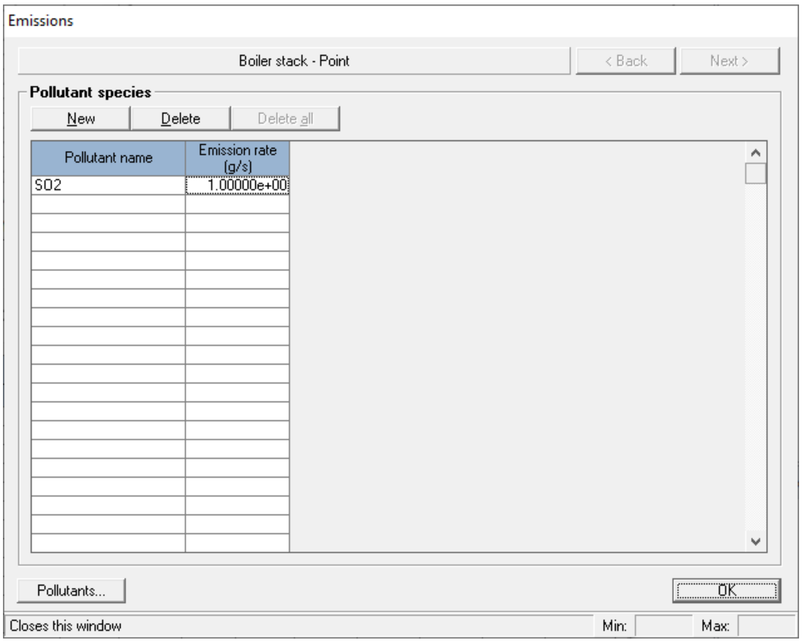


Figure 8.3 − Example 1: the **Emissions** screen.

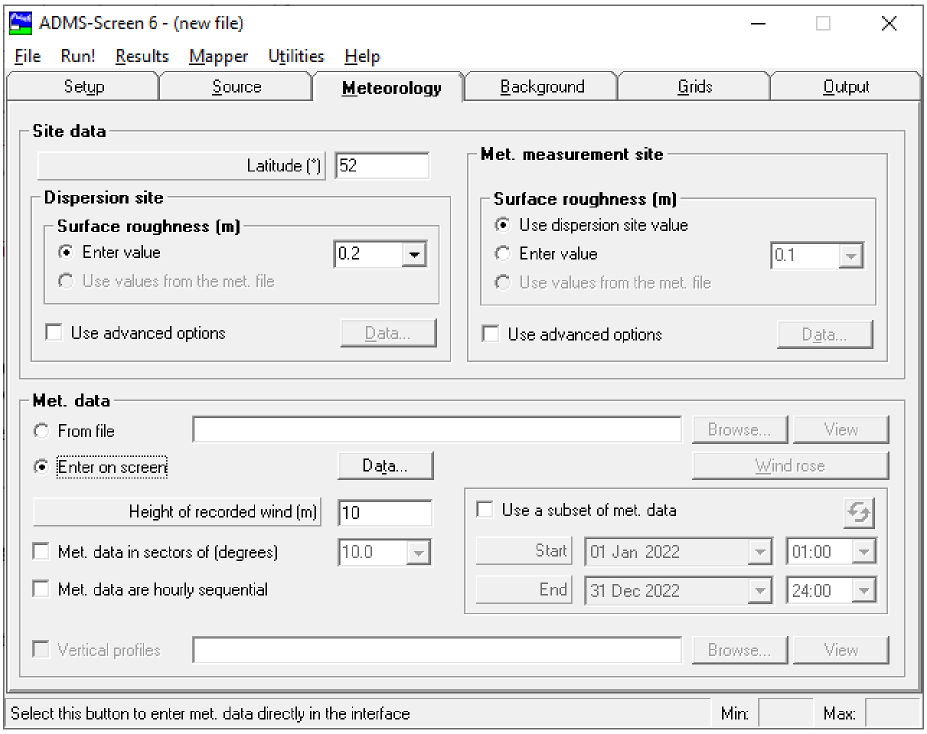


Figure 8.4 − Example 1: the **Meteorology** screen.

The minimum data required are either the *wind speed, wind direction, year, Julian day number, time of day and cloud cover*, OR the *wind speed, wind direction and surface heat flux*.

If any of the other meteorological parameters shown on the right of the screen are known, they can be added by clicking in the appropriate check boxes. If you have no available data to enter here it is better to let the model calculate parameters from the existing data rather than make an inaccurate assumption.

For this example we want to look at the influence on dispersion of meteorological conditions that correspond *approximately* to the Pasquill-Gifford stability categories A to G. However, it is important to understand that there is no exact equivalence between these stability categories and the description of boundary-layer meteorology in terms of boundary layer height, *h*, and the Monin-Obukhov length, L_{MO}, used in ADMS-Screen (Section 9.2).

In this example we will enter wind speed, wind direction and surface heat flux plus the boundary layer height.

Step 11 Select **surface sensible heat flux, (W/m2)** in the **Surface heat flux variables** section and use the **New** button to enter the seven lines of meteorological data as shown in **Figure 8.5.** Once done, click **OK** to return to the main **Meteorology** screen.

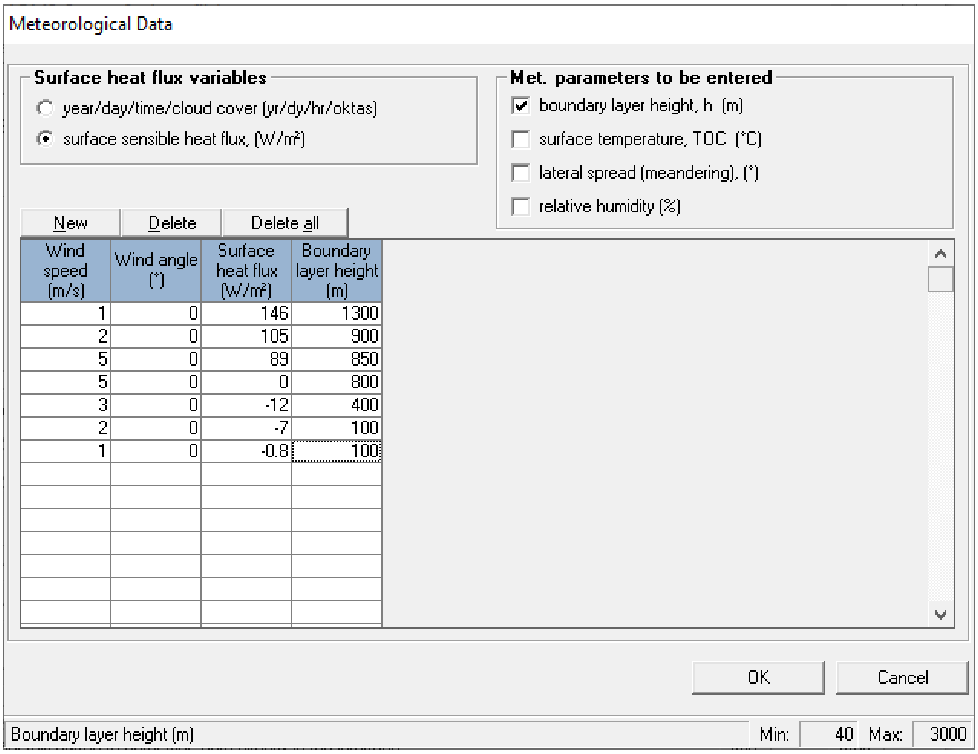


Figure 8.5 − Example 1: the **Meteorological Data** screen.

The next screen is the **Background** screen. As we don't want to enter any background concentrations for this example leave this set to none as shown in **Figure 8.6**.

Now the area over which we want to calculate concentrations must be defined. This is carried out in the **Grids** screen.

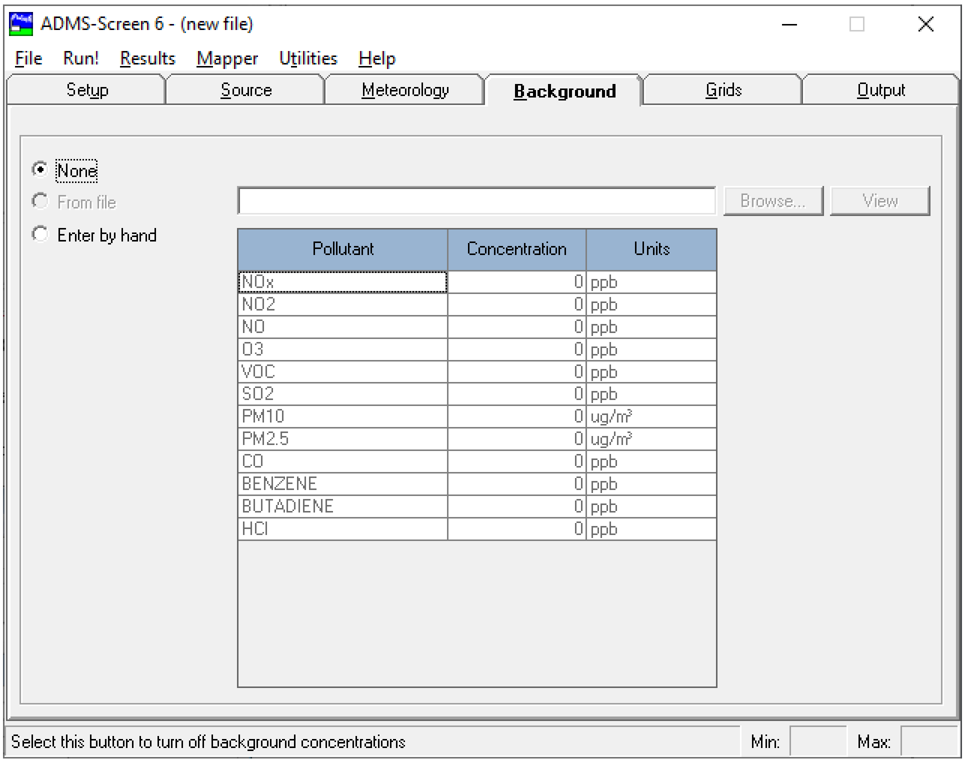


Figure 8.6 − Example 1: the **Background** screen.

The regular Cartesian grid is set up by specifying the minimum and maximum X, Y and Z coordinates of your calculation grid and the number of points in each direction. The maximum number of points in each direction is 51. It is often a good idea to use a 31×31 point grid or a 51×51 point grid so that concentrations will be calculated at an equal number of points in both directions from a central reference point (e.g. (0,0)) as well as *at* that reference point.

The default grid is a ground level Cartesian grid with 31 regularly spaced points in the X and Y directions with a width of 2 km in each direction. The grid is centred on (0,0) which was the source position given in the **Source** screen.

Step 12 Set the minimum X and Y values to be -500 m and the maximum to be 500 m and select the number of points in the X and Y directions to be 21, as shown in **Figure 8.7**.

This will create a ground level calculation grid extending out to 500 m in each direction from the central (0,0) location with a grid spacing of 50 m.

Click on the **Output** tab to enter the **Output** screen (**Figure 8.8**). The default screen shows a **Source** output for the "Boiler stack" selected, but no pollutant output is specified.

Step 13 Click on **New** in the **Pollutant output** box to add a line to the table.

The default is for the model to calculate short-term (**ST**) concentrations of NO_X with an averaging time of 1 hour, giving the results in units of μg/m^3.

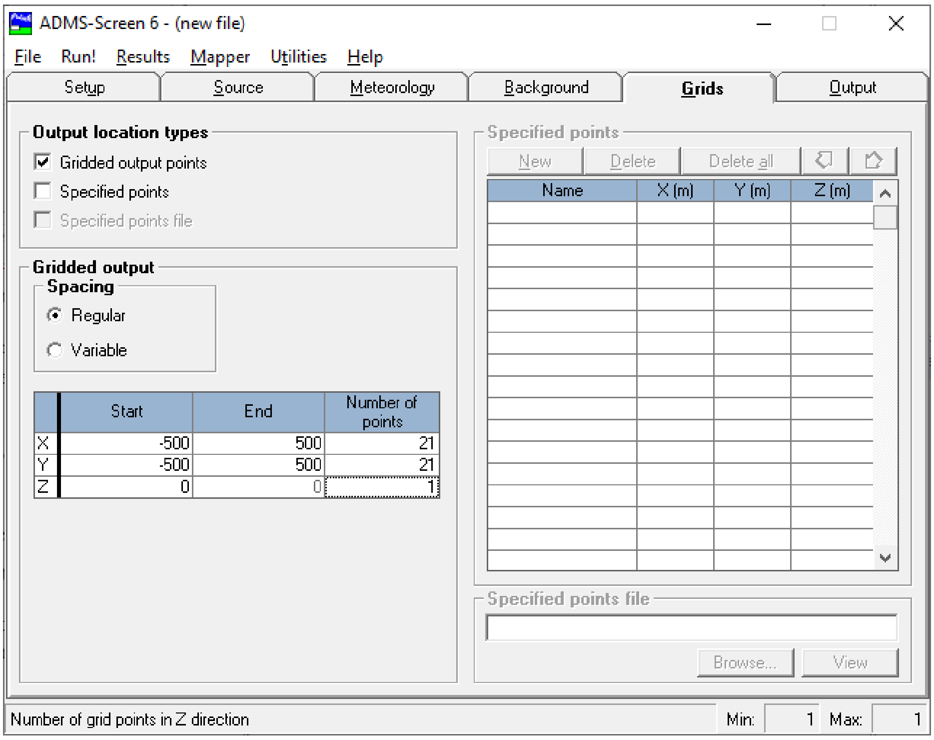


Figure 8.7 − Example 1: the **Grids** screen.

Step 14 Change the output pollutant to SO_2 by clicking on the down arrow in the pollutant name cell and selecting SO_2 from the list of pollutants that appears. *Care should be taken to make sure that the output pollutant chosen is the pollutant emitted from the stack.*

Make sure that there are red ticks in the **Include** column and the **Source** output table (next to the "Boiler stack"). If not, click on the appropriate cell or enter **Y** in the cell.

If no pollutants are selected in the ***Pollutant output*** *table, the program will not run successfully. You MUST choose at least one.*

Your **Output** screen should look as in **Figure 8.8**.

Having now specified all the input required, you just need to save the configuration before running the model.

Step 15 Click on **File**, **Save** or **Save As...** and save the file as *Ex1_point.apl*.

If you are asked about verification click on **Yes** to run the verification checks; see Section 2.5 for more details.

Step 16 Click on **Run!** to run the model.

The run will only take a few seconds for this example. A run window similar to **Figure 8.9** will appear. The file name is shown in the title bar of the window. The first messages to appear on the screen are related to the licence details for the model, followed by messages related to the meteorological data.

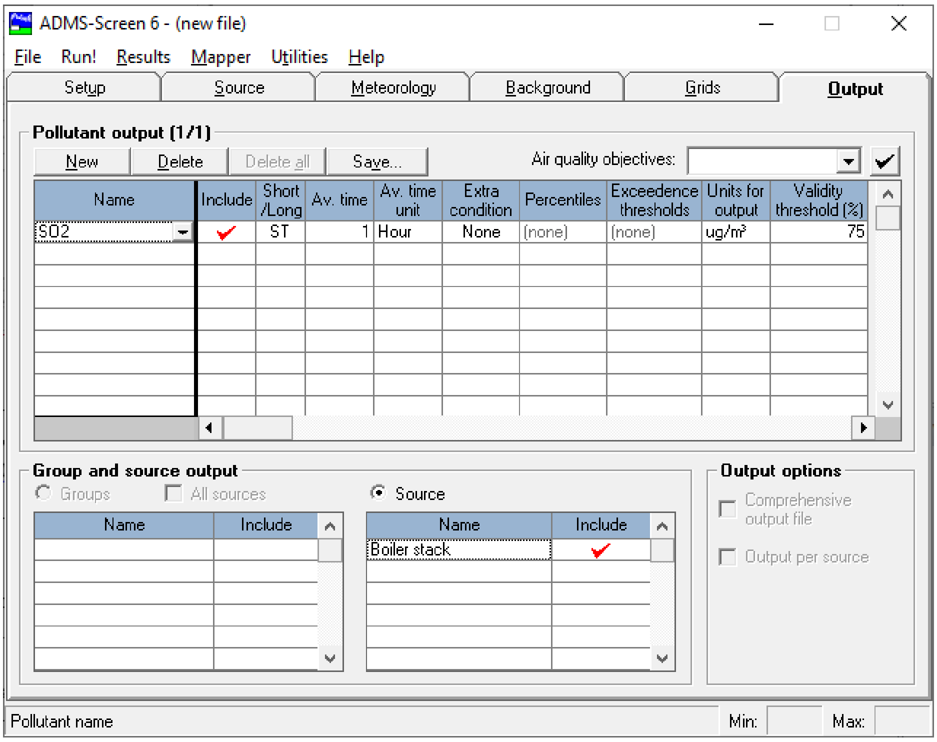


Figure 8.8 − Example 1: the **Output** screen.

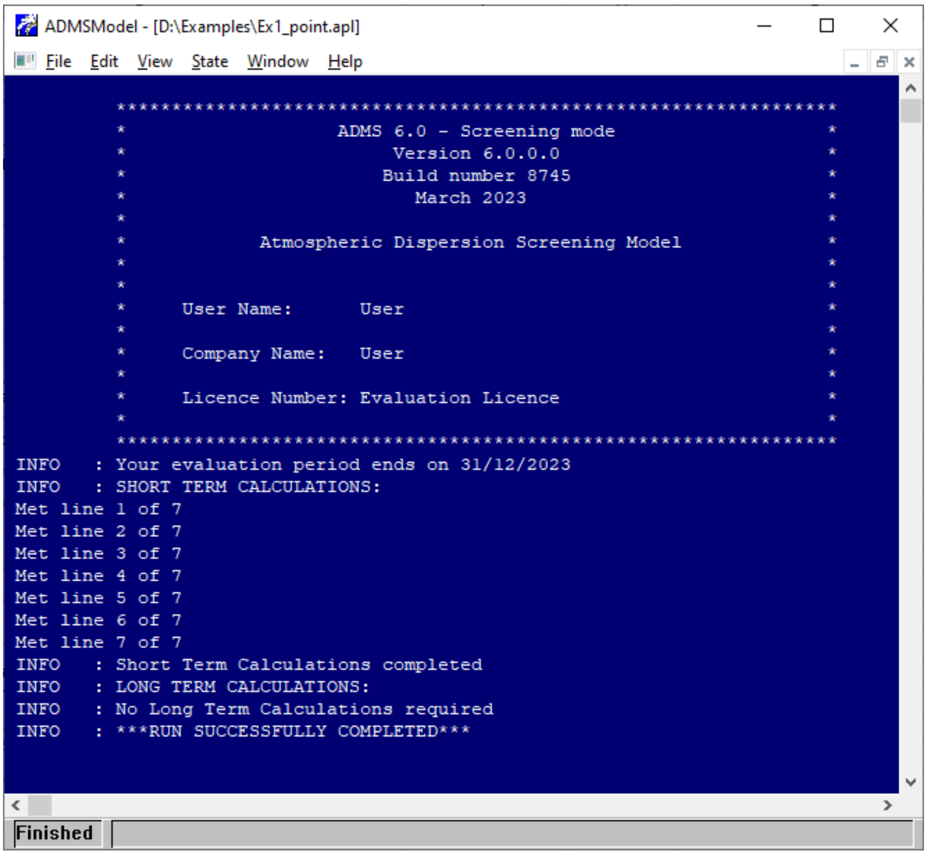


Figure 8.9 − Example 1: the run window.

At the end of the run the dialog box shown in **Figure 8.10** will appear. This means that the run has completed successfully.

Step 17 Click on **Yes** to close the window shown in **Figure 8.10**.

Alternatively, click on **No** to leave the window open and view the screen messages. Use the **File**, **Exit** command from the menu bar of the run window to return to the main interface of ADMS-Screen.

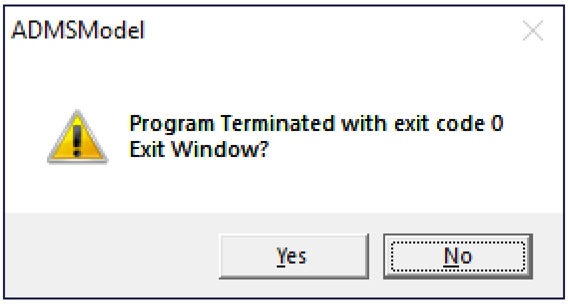


Figure 8.10 − Example 1: end-of-run dialog box.

8.1.2 Viewing output results

In ADMS-Screen, the results can be viewed in three ways, namely line plots, contour plots and numerically. Go to the main **Results** menu at the top of the interface to see these three options.

The line plotting utility

This utility plots line graphs of quantities such as the ground-level concentration underneath the plume centreline, plume parameters, etc., and is described in Section 6.3.

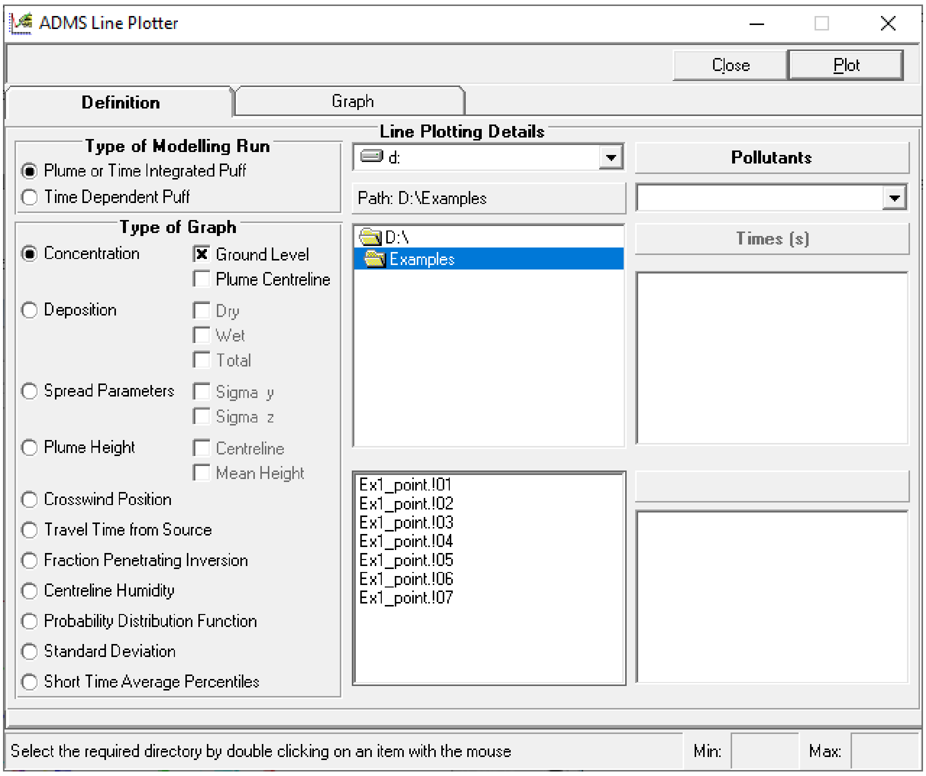


Figure 8.11 − Example 1: the **ADMS Line Plotting** utility.

Step 1 Launch the utility by selecting the **Results**, **Line Plot** menu command to access the screen shown in **Figure 8.11**.

For our example, there are 7 individual output files, one for each line of meteorological data entered in the **Meteorology** screen. These have the extension *.!n*, where *n* is the number of the line of meteorological data. Thus, in this case, the results in the file *Ex1_point.!01* are for the highly convective meteorological conditions of the first line of data, which corresponds approximately to a category A stability. Similarly the results in the file *Ex1_point.!07* are for the extremely stable meteorological conditions of the seventh line of data, which corresponds approximately to a category G stability.

The default line plots that are created are the ground level concentrations underneath the plume centreline.

Step 2 To look at such results for any one output file, click on that file name and press **Plot**.

To look at such results for all output files, select all seven output files (using the **SHIFT** key) and press **Plot**, so that we can compare the ground level concentrations for meteorological condition on one graph.

This composite graph is shown in **Figure 8.12**. Different colours and symbols are used to distinguish data from each file plotted.

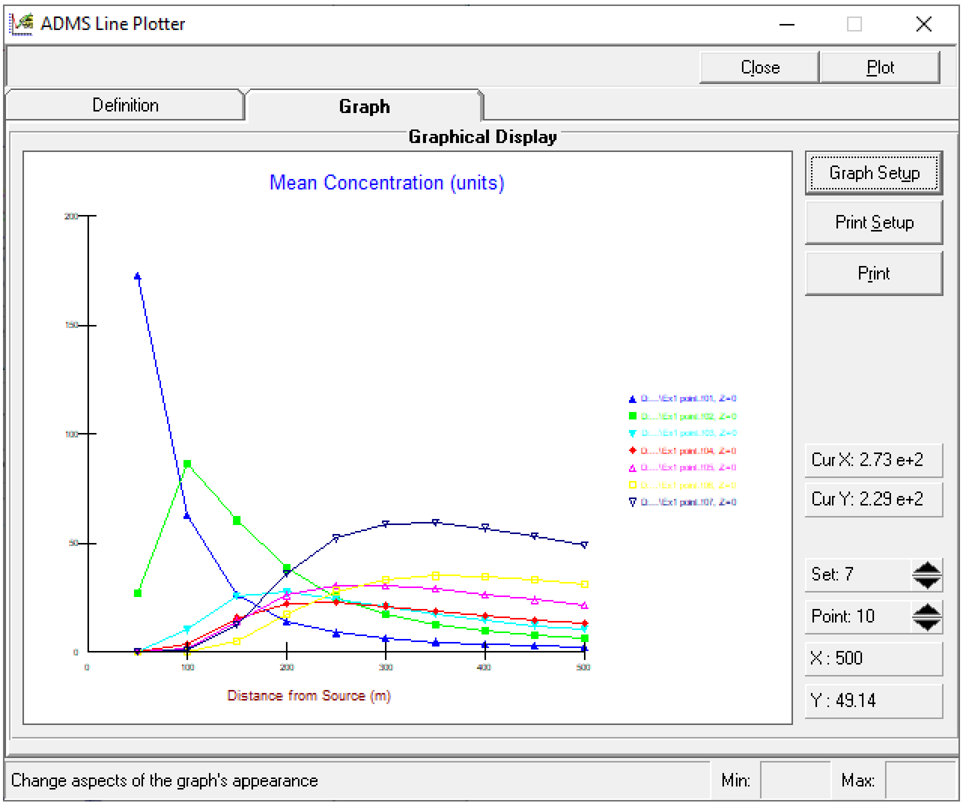


Figure 8.12 − Example 1: ground-level concentrations for all met. data lines.

From the graph, it can be seen that the maximum ground-level concentration occurs under conditions corresponding to the first meteorological line, i.e. in very convective conditions, and occurs very close to the source. The lowest maximum ground-level concentration occurs with the fourth meteorological line, i.e. under neutral stability conditions.

Concentrations are calculated at distances starting 50 m downwind from the source, as this is the grid spacing defined in the **Grid** *screen. To calculate concentrations at shorter downwind distances, a finer output grid or the* **Specified points** *option on the* **Grids** *screen should be used.*

Other results can be plotted. Here, in order to plot the plume spread parameters, go back to the **Definition** screen.

Step 3 Click on the **Definition** tab to return to the screen shown in **Figure 8.11**.

Step 4 Click on **Spread Parameters** and check the **Sigma z** option.

Step 5 Select all the files again and click on **Plot**.

This time the vertical spread of the plume is shown, for each meteorological condition, as shown in **Figure 8.13**. The figure shows the vertical plume spread as a function of distance downstream. This illustrates that the greatest vertical spread occurred with the most convective conditions and the least vertical spread with stable conditions.

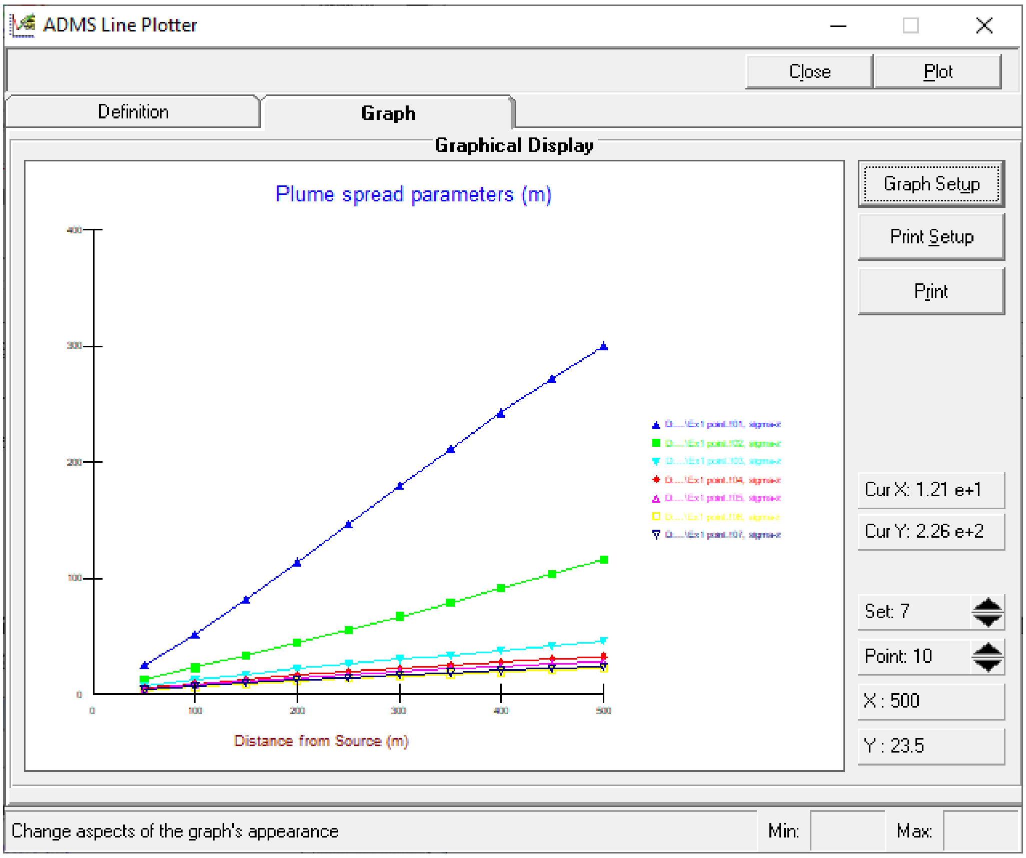


Figure 8.13 − Example 1: vertical plume spread parameters for all met. data lines.

The legends, titles and symbols in a line plot can be edited and/or enlarged or reduced by clicking on the **Graph Setup** *button. The graphs can also be saved and imported into documents for later reporting. For further details, please refer to Section 6.3.*

Contour Plotting

The concentration results can also be viewed as contour plots over the output grid specified on the **Grids** screen. The contour plots are produced in the Mapper with the **2-D Output Plotter** utility (see full details on the utility in Section 6.2).

To create a contour plot for the run that has just completed, proceed as follows. All the information for contour plotting from this run is contained in a single output file, *Ex1_point.gst*. This file contains a data set of SO_2 concentrations for each line of meteorological data.

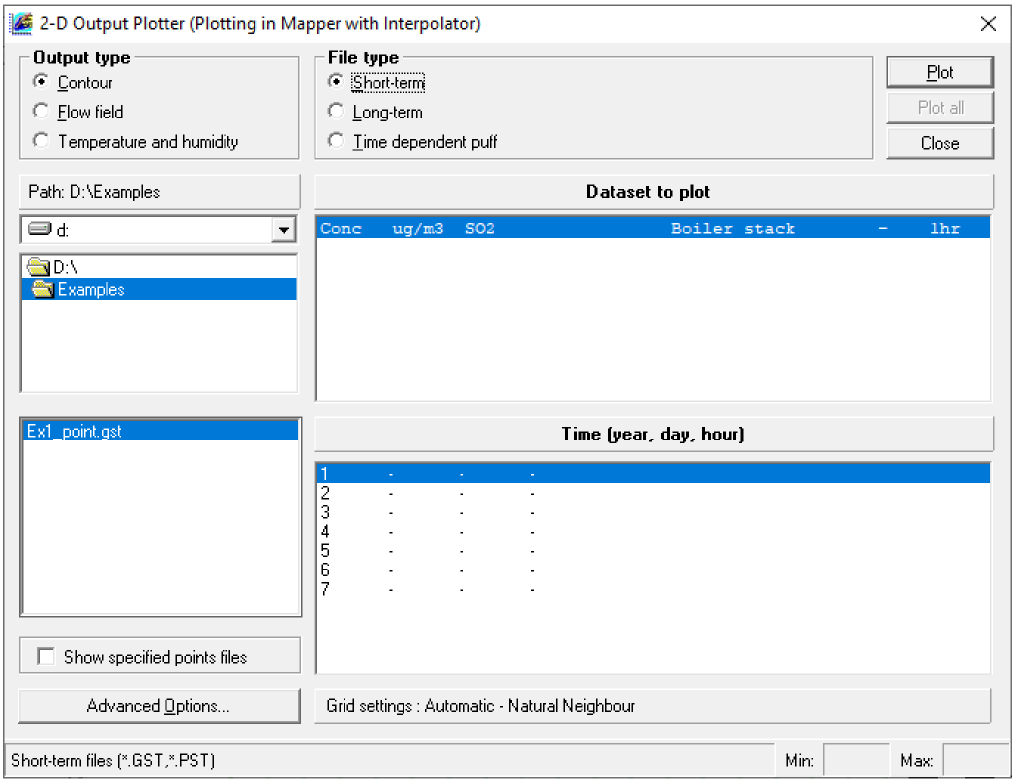


Figure 8.14 – Example 1: the **2-D Output Plotter** utility.

Step 1 Go to **Results, Contour plot, Mapper** to launch the Mapper and the **2-D Output Plotter** utility. Select **Contour** and then **Short-term** to produce a screen like that shown in **Figure 8.14**.

Step 2 Browse to the directory containing the *.apl* file and select the appropriate *.gst* file.

Step 3 Highlight the **Time** and the **Dataset to plot** for the file you want to plot. (You can only make one contour plot at a time.)

Line 1 in the **Time** box at the bottom right of the screen corresponds to the first line of meteorological data (very convective) and line 7 corresponds to the last line of data (very stable).

Step 4 Click on **Advanced**, check the **Specify number of grid lines** and set the number of grid lines to 100 for **Both X and Y.**

Step 5 Click **OK** to return to the main **2-D Output plotter** screen.

Step 6 Click on **Plot.**

This will first launch the **Save Surfer Grid File As…** dialogue box – save with the default name, in this case *Ex1_point.grd*. A contour plot of the ground-level concentration for that particular meteorological condition then appears in the Mapper. **Figure 8.15** shows the automatically generated contour plot for line 2 (convective conditions).

The title of the plot clearly indicates which file, source and pollutant the results correspond to. The plot can be edited to show more contour levels, change colours, etc.

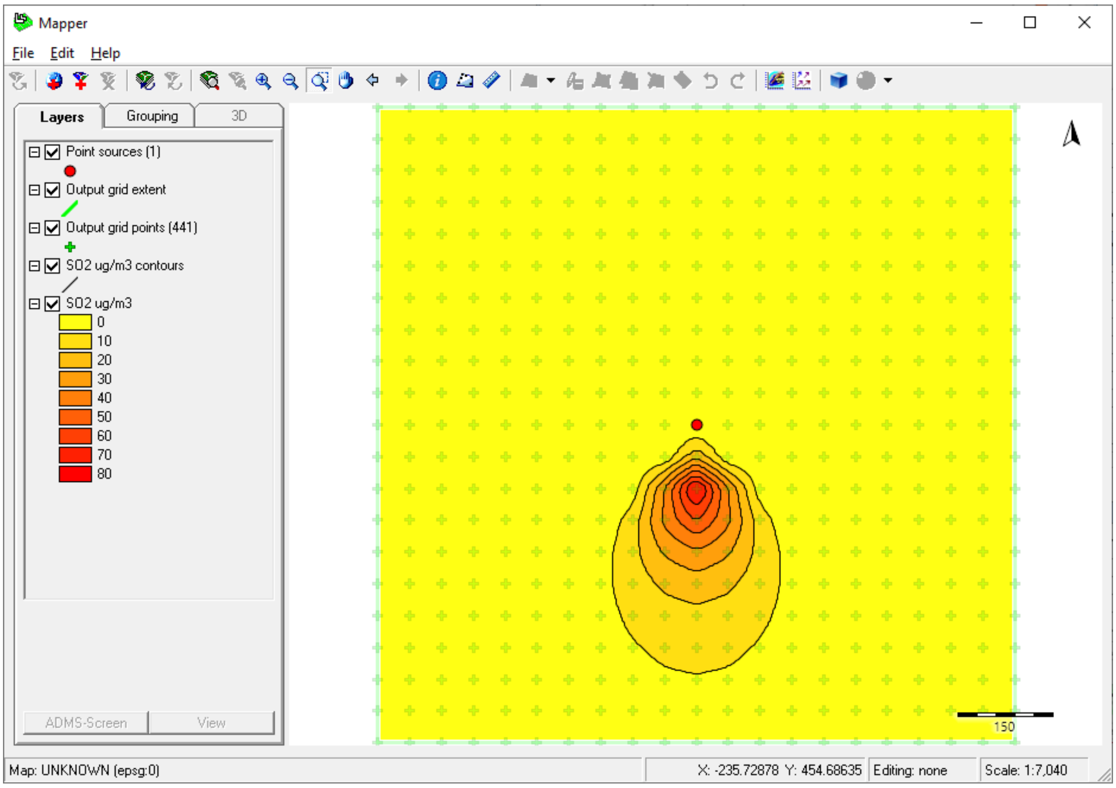


Figure 8.15 − Example 1: concentration contour plot (line 2 of met. data).

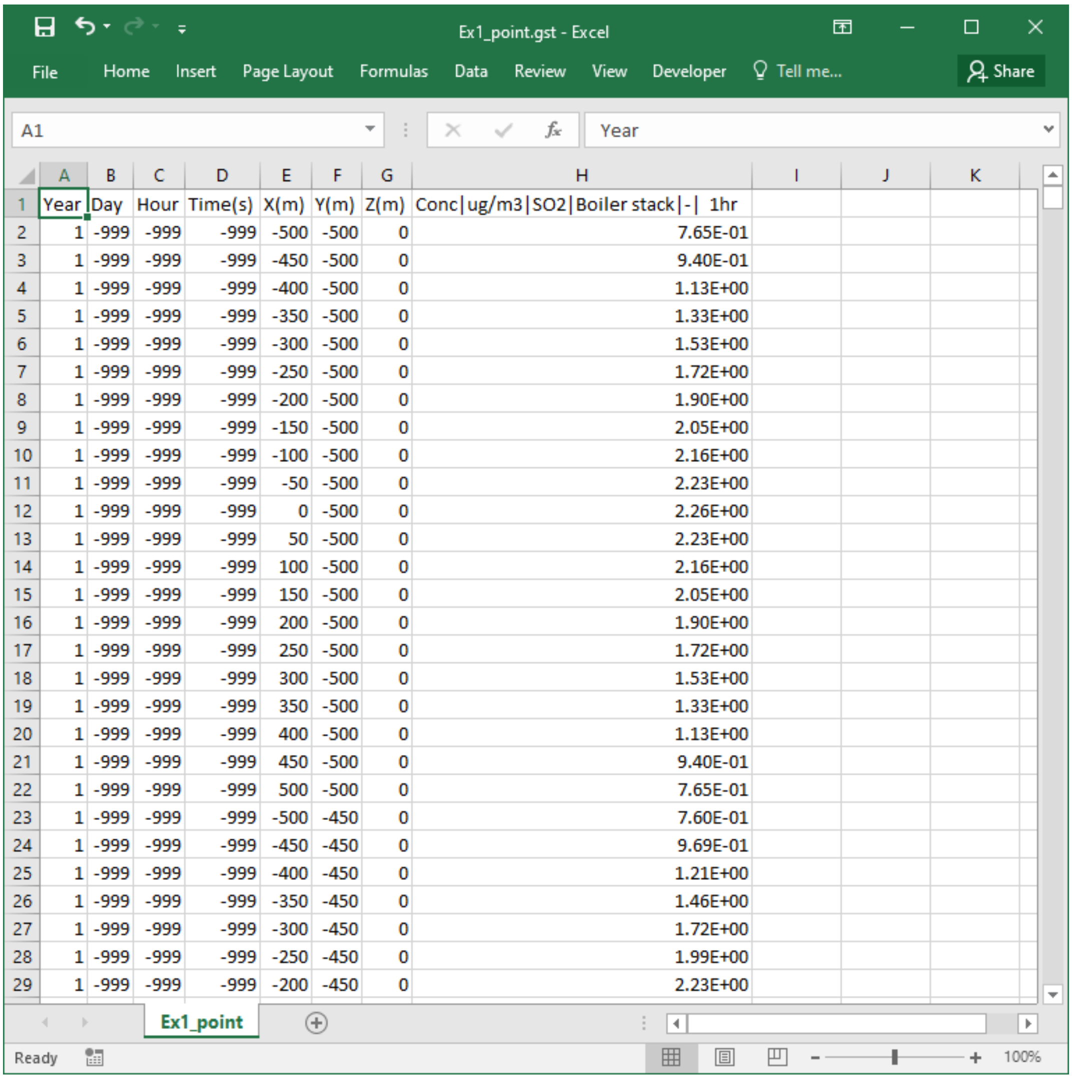
You can return to the **2-D Output plotter** screen and select another dataset or time to plot. The contour plot will be added to the Mapper as a new data layer.

Numerical results

A number of numerical output files are created for each run. These numerical files can be viewed by clicking on the **Results**, **Numerical output** menu command. This automatically opens an editor on your machine such as Notepad, WordPad or Microsoft Excel and gives an **Open** dialogue box listing the output files that are available for this run.

Users may find the files easiest to read when opened in Excel.

An example of a numerical output file is shown in **Figure 8.16** below. The user can read the concentration at any particular grid point for a particular meteorological data line (indicated by the number in the first column). If the year is a meteorological variable (i.e. either `YEAR` is defined in the *.met* file or **Year** has been entered on the **Meteorology** screen), then the first column contains the year, otherwise it contains the number of the meteorological data line.



	A	B	C	D	E	F	G	H
1	Year	Day	Hour	Time(s)	X(m)	Y(m)	Z(m)	Conc|ug/m3|SO2|Boiler stack|-| 1hr
2	1	-999	-999	-999	-500	-500	0	7.65E-01
3	1	-999	-999	-999	-450	-500	0	9.40E-01
4	1	-999	-999	-999	-400	-500	0	1.13E+00
5	1	-999	-999	-999	-350	-500	0	1.33E+00
6	1	-999	-999	-999	-300	-500	0	1.53E+00
7	1	-999	-999	-999	-250	-500	0	1.72E+00
8	1	-999	-999	-999	-200	-500	0	1.90E+00
9	1	-999	-999	-999	-150	-500	0	2.05E+00
10	1	-999	-999	-999	-100	-500	0	2.16E+00
11	1	-999	-999	-999	-50	-500	0	2.23E+00
12	1	-999	-999	-999	0	-500	0	2.26E+00
13	1	-999	-999	-999	50	-500	0	2.23E+00
14	1	-999	-999	-999	100	-500	0	2.16E+00
15	1	-999	-999	-999	150	-500	0	2.05E+00
16	1	-999	-999	-999	200	-500	0	1.90E+00
17	1	-999	-999	-999	250	-500	0	1.72E+00
18	1	-999	-999	-999	300	-500	0	1.53E+00
19	1	-999	-999	-999	350	-500	0	1.33E+00
20	1	-999	-999	-999	400	-500	0	1.13E+00
21	1	-999	-999	-999	450	-500	0	9.40E-01
22	1	-999	-999	-999	500	-500	0	7.65E-01
23	1	-999	-999	-999	-500	-450	0	7.60E-01
24	1	-999	-999	-999	-450	-450	0	9.69E-01
25	1	-999	-999	-999	-400	-450	0	1.21E+00
26	1	-999	-999	-999	-350	-450	0	1.46E+00
27	1	-999	-999	-999	-300	-450	0	1.72E+00
28	1	-999	-999	-999	-250	-450	0	1.99E+00
29	1	-999	-999	-999	-200	-450	0	2.23E+00

Figure 8.16 − Example 1: *.gst* file viewed numerically.

Further work

Try running this example for different stack heights (e.g. 0 m, 150 m) to see which meteorological conditions will lead to the highest maximum ground-level concentrations as the stack height is varied.

8.2 Example 2: Long-term average and percentile concentrations

The previous example looked at the effect of seven individual meteorological conditions on the dispersion of a plume from a single stack. These were specific conditions designed to approximate different classes of atmospheric stability.

Most commonly, we are interested in the effect of *real recorded* meteorological data on the dispersion of plumes in the atmosphere. We want to know the maximum short-term concentrations together with the long-term average concentrations that are most likely to occur for a particular process in a particular part of the country, over a period of, for instance, a day, a year or 10 years.

In this next example, we will model a single stack with a height of 45 m that represents a boiler stack and is located close to a building of height 15 m. We are interested in the ground-level concentrations of SO_2 and NO_X that occur over a calculation grid area of 1.5 km in each direction from the stack, paying particular attention to the concentrations at specific receptor points in the area.

We may want to compare the modelled results with regulatory standards, notably the NAQS 99.9th percentile of 15 minute averages for SO_2, and the 99.79th percentile of 1 hour averages for NO_X. This normally requires a long-term average concentration calculation to be carried out, either with a single year of hourly sequential meteorological data or with 10 years of statistically analysed meteorological data for that site. However, to save time for this example, we will use one day of hourly sequential data.

We want to know the long-term average concentration (in this case the daily average) together with percentile concentrations recorded at each point over the *whole day*.

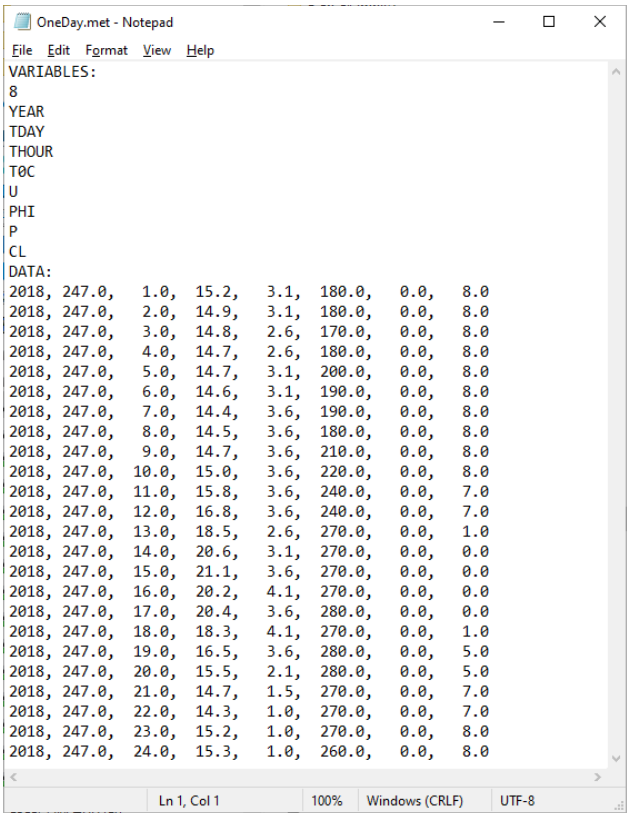
If we were using a meteorological data file containing a year of data, the long-term average would be the ***annual*** *average concentration.*

Although the two pollutants have different averaging times, ADMS-Screen has the ability to combine different averaging times in a single run. Hence we need only perform one run to calculate long-term average concentrations for SO_2 with a 15-minute averaging time and for NO_X with a 1-hour averaging time.

8.2.1 Setting up the run

The meteorological data file to be used in this example is *oneday.met*, which is a sample data set provided with the model (it may be found in the directory *<install_path>\Data*). This file may be viewed by opening it in an editor such as Notepad, WordPad or Microsoft Excel as a comma-separated variable file. A portion of the file is shown below in **Figure 8.17**.

This file contains a single day of hourly sequential meteorological data. It is for day number 247 of the year (4th September in a non-leap year) and it can be seen that the file contains data for hour 1 to hour 24 for that day.



```
VARIABLES:
8
YEAR
TDAY
THOUR
T0C
U
PHI
P
CL
DATA:
2018, 247.0,   1.0,  15.2,   3.1,  180.0,   0.0,   8.0
2018, 247.0,   2.0,  14.9,   3.1,  180.0,   0.0,   8.0
2018, 247.0,   3.0,  14.8,   2.6,  170.0,   0.0,   8.0
2018, 247.0,   4.0,  14.7,   2.6,  180.0,   0.0,   8.0
2018, 247.0,   5.0,  14.7,   3.1,  200.0,   0.0,   8.0
2018, 247.0,   6.0,  14.6,   3.1,  190.0,   0.0,   8.0
2018, 247.0,   7.0,  14.4,   3.6,  190.0,   0.0,   8.0
2018, 247.0,   8.0,  14.5,   3.6,  180.0,   0.0,   8.0
2018, 247.0,   9.0,  14.7,   3.6,  210.0,   0.0,   8.0
2018, 247.0,  10.0,  15.0,   3.6,  220.0,   0.0,   8.0
2018, 247.0,  11.0,  15.8,   3.6,  240.0,   0.0,   7.0
2018, 247.0,  12.0,  16.8,   3.6,  240.0,   0.0,   7.0
2018, 247.0,  13.0,  18.5,   2.6,  270.0,   0.0,   1.0
2018, 247.0,  14.0,  20.6,   3.1,  270.0,   0.0,   0.0
2018, 247.0,  15.0,  21.1,   3.6,  270.0,   0.0,   0.0
2018, 247.0,  16.0,  20.2,   4.1,  270.0,   0.0,   0.0
2018, 247.0,  17.0,  20.4,   3.6,  280.0,   0.0,   0.0
2018, 247.0,  18.0,  18.3,   4.1,  270.0,   0.0,   1.0
2018, 247.0,  19.0,  16.5,   3.6,  280.0,   0.0,   5.0
2018, 247.0,  20.0,  15.5,   2.1,  280.0,   0.0,   5.0
2018, 247.0,  21.0,  14.7,   1.5,  270.0,   0.0,   7.0
2018, 247.0,  22.0,  14.3,   1.0,  270.0,   0.0,   7.0
2018, 247.0,  23.0,  15.2,   1.0,  270.0,   0.0,   8.0
2018, 247.0,  24.0,  15.3,   1.0,  260.0,   0.0,   8.0
```

Figure 8.17 − Example 2: The meteorological data file *oneday.met* viewed in Notepad.

To set up the example, proceed as follows.

Step 1 Open ADMS-Screen and click on **File**, **New** to create a new input file, i.e. a default input file or "clean sheet" in which to enter data.

Step 2 In the **Setup** screen, add entries to the **Name of site** and **Name of project** boxes and ensure the **Coordinate system** is set to "Unspecified regular Cartesian".

Step 3 Select to include a building in the model options section, click on **Enter Parameters...** to open the Buildings screen.

Step 4 In the Buildings screen, click on **New**, to enter a line of data describing the building and give it the name 'Warehouse'.

Step 5 Edit the building parameters so that the modelled building is rectangular, centred at (0,0), 15 m high, 100 m long, 20 m wide, and the length orientated 15° clockwise from the North.

Compare with the screens shown in **Figure 8.18** and **Figure 8.19**.

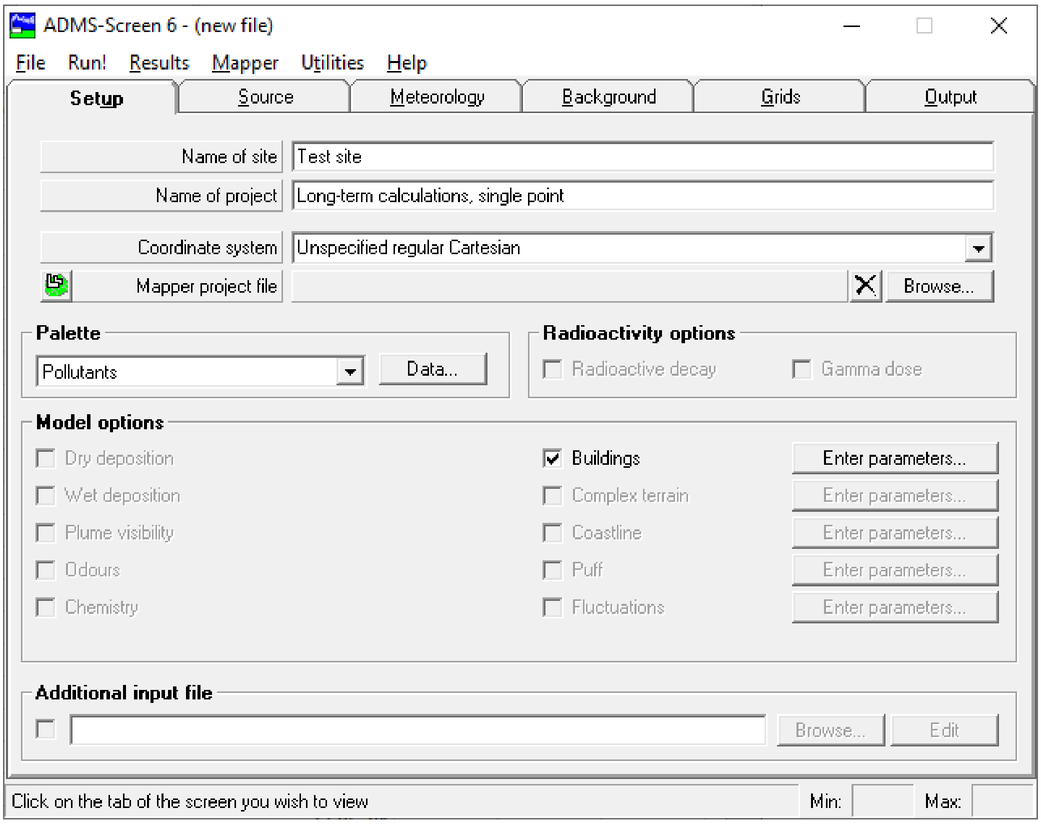


Figure 8.18 − Example 2: the **Setup** screen.

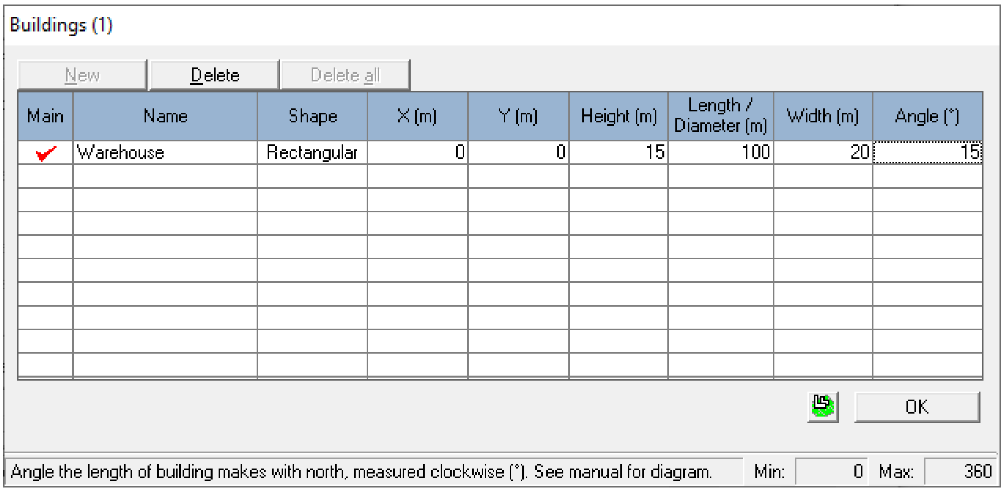


Figure 8.19 − Example 2: the **Buildings** screen.

Step 6 Go to the **Source** screen and enter a new point source. Call it "Boiler Stack" and specify a height of 45 m, a diameter of 0.5 m, an exit velocity of 20 m/s and a temperature of 65°C. Position the stack at (X,Y) = (20,0).

Step 7 Click on **Emissions...** and click on **New** to include two pollutants in the table. Select NO_X from the drop-down menu as the first pollutant species with an emission rate of 7.5 g/s and SO_2 as the second species with an emission rate of 10 g/s. Click **OK** to return to the **Source** screen.

Step 8 In the **Meteorology** screen, leave the **Latitude** as 52° and set the dispersion site surface roughness to **Parkland, open suburbia**, corresponding to 0.5 m. Now choose the **From file** option for the meteorological data and click on the **Browse...** button to locate the file *OneDay.met*. Click on **Met. data are hourly sequential**. Click on **Met. data in sectors of (degrees)** and select **10.0** from the drop-down box, to indicate that the wind directions in the meteorological data were recorded to the nearest 10°.

The **Meteorology** screen should match that shown in **Figure 8.20**.

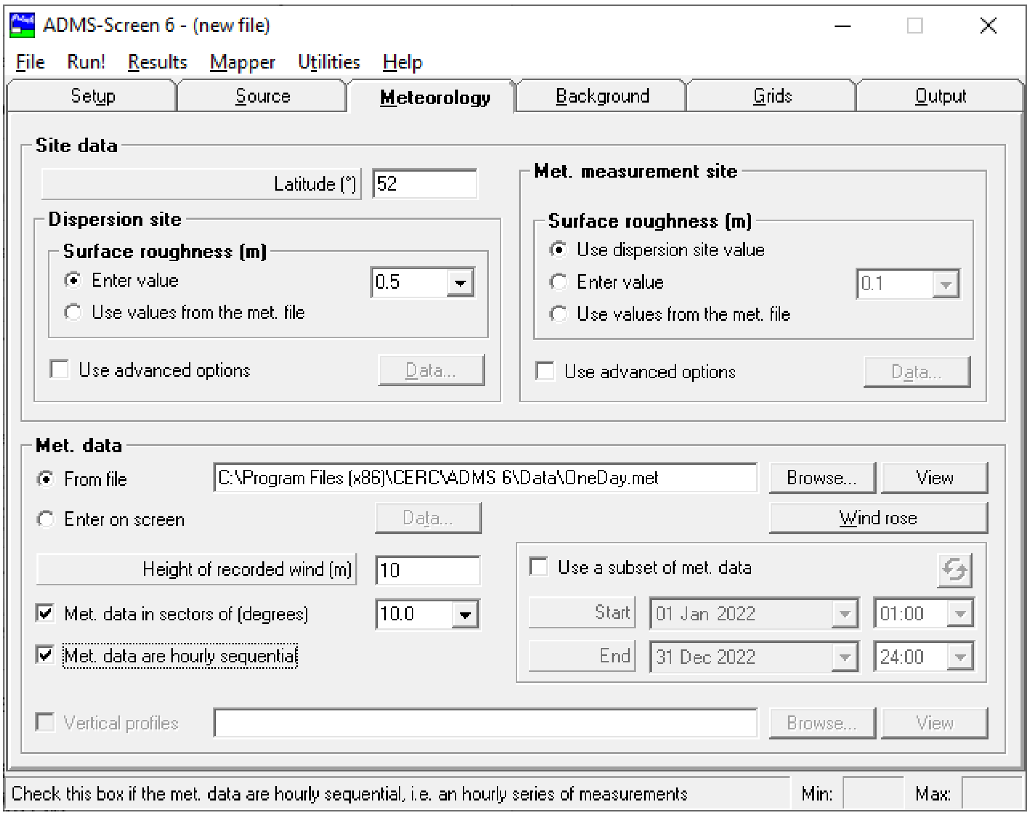


Figure 8.20 − Example 2: the **Meteorology** screen.

Step 9 There is no background data to add, so this screen can be skipped.

The output will be calculated on a regular Cartesian grid over our chosen area *and* at specific receptor locations where there may be a school, a site boundary or some other sensitive area. To create a Cartesian grid extending to 1.5 km from the source in each direction we want to set up as detailed a grid as possible, with sensible grid spacing in order to capture the maximum concentrations. A good grid for this problem would be as shown in **Figure 8.21**.

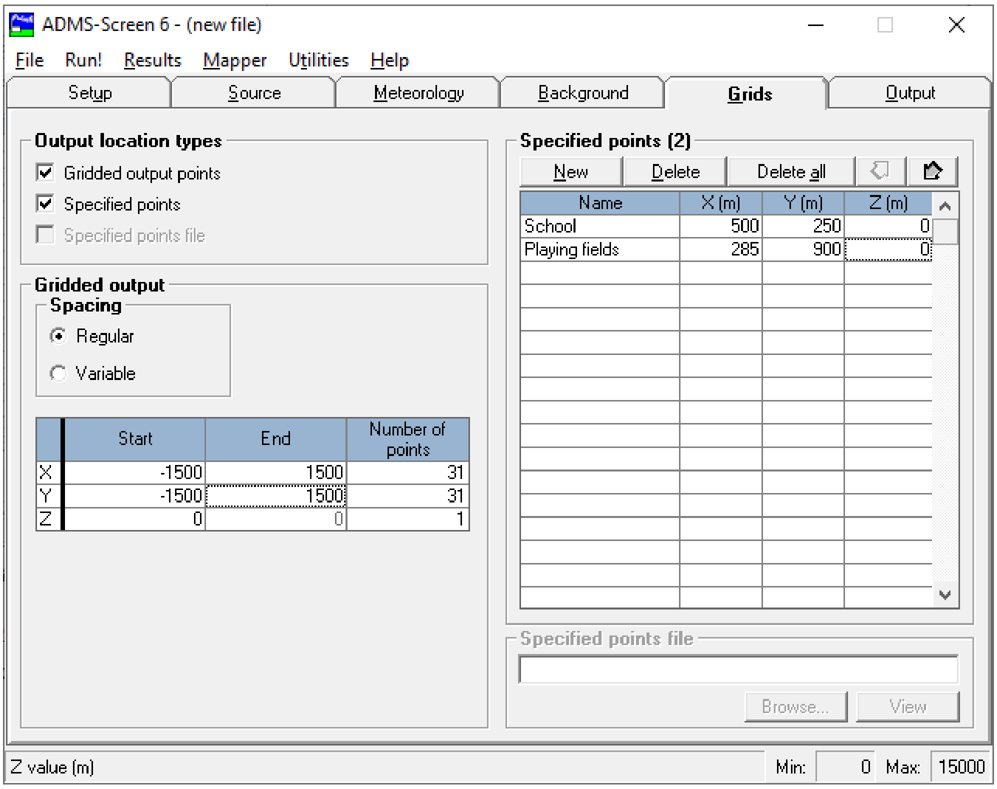


Figure 8.21 − Example 2: the **Grids** screen.

Step 10 Go to the **Grids** screen and tick **Gridded output points** and **Specified points** under **Output location types**.

Step 11 Set up the grid as shown in **Figure 8.21**. To enter (up to 100) specified points, click on **New** for each point. Each point requires X, Y and Z coordinates relative to (0,0,0). (By default the Z coordinate is zero, i.e. at ground level, but it can be at any elevation required.)

It is now time to define the required output.

Step 12 In the **Output** screen click on **New** to add a line to the **Pollutant output** table.

The default is for the model to calculate short-term **ST** concentrations of NO_X with an averaging time of 1 hour, giving the results in units of $\mu g/m^3$.

Step 13 Select **LT** by clicking in the **Short/Long** cell to select long-term calculations. Go to the **Percentiles** cell and click on the drop-down menu. Type 99.79 then press **Enter** to add the 99.79th percentile of hourly means for NO_X.

Step 14 Click on **New** to add a second line to the pollutant output table. Change the output pollutant to SO_2 by clicking on the down arrow in the pollutant name cell and selecting SO_2 from the drop-down list of pollutants that appears. Select **LT** and change the averaging time to 15 minutes. Go to the **Percentiles** cell and type 99.9 then press **Enter** to add the 99.9th percentile of 15 minute means for SO_2.

Step 15 Make sure that there are red ticks in the **Include** cells of the pollutant output table (next to NO_X and SO_2) and the source output table (next to “Boiler stack”). If not, click on the appropriate cell or enter **Y** in that cell.

Compare your input with **Figure 8.22** below.

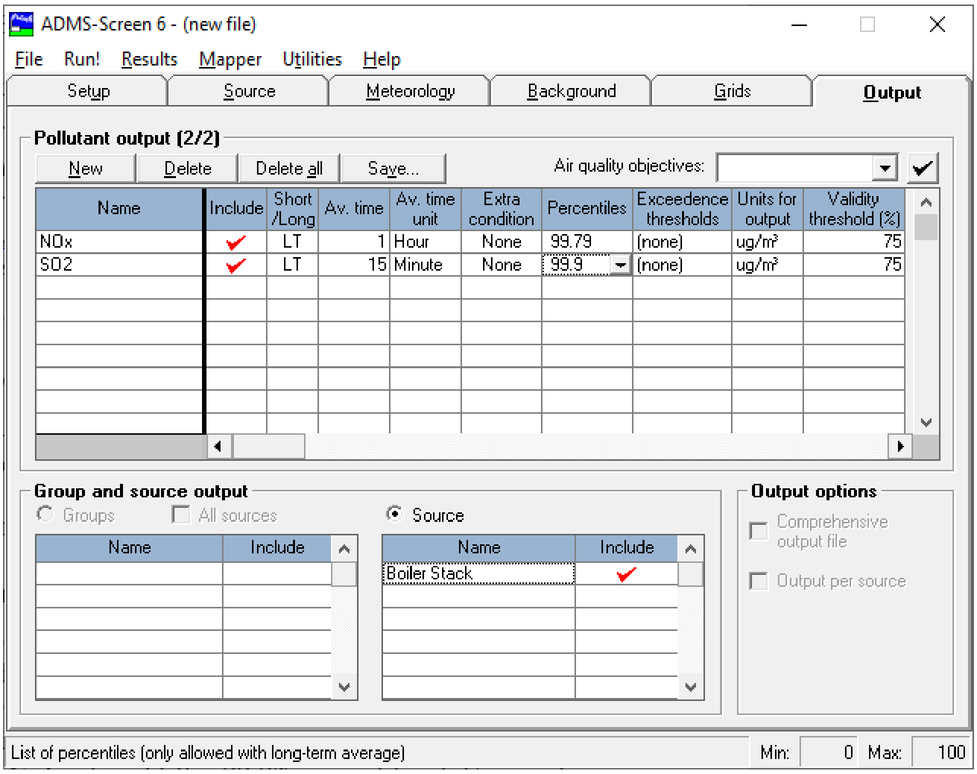


Figure 8.22 − Example 2: the **Output** screen.

Step 16 Save the file as *Ex2_building.apl* and run the model.

For the long-term average calculation there is an output file created called *Ex2_building.glt* containing four datasets, namely long-term average concentration results and percentile results for each of the two pollutants, together with a file called *Ex2_building.plt* giving the same results for each of the specified points.

8.2.2 Viewing output results

There is no line plot for a long-term average calculation. However, contour plots are available. Go to **Results, Contour plot, Mapper** and select **Contour** and **Long term** as shown in **Figure 8.23** below. Click on **Advanced**, check the **Specify number of grid lines** and set the number of grid lines to 100 for **Both X and Y.**

Plot the four data sets in turn. The contour plots for the long-term average and the 99.79th percentile of hourly average concentrations of NO_X are shown in **Figure 8.24**. From the contour plot the maximum average NO_X concentration is about 20 µg/m^3.

For accurate numerical values, always read the actual numerical maximum from the appropriate numerical file.

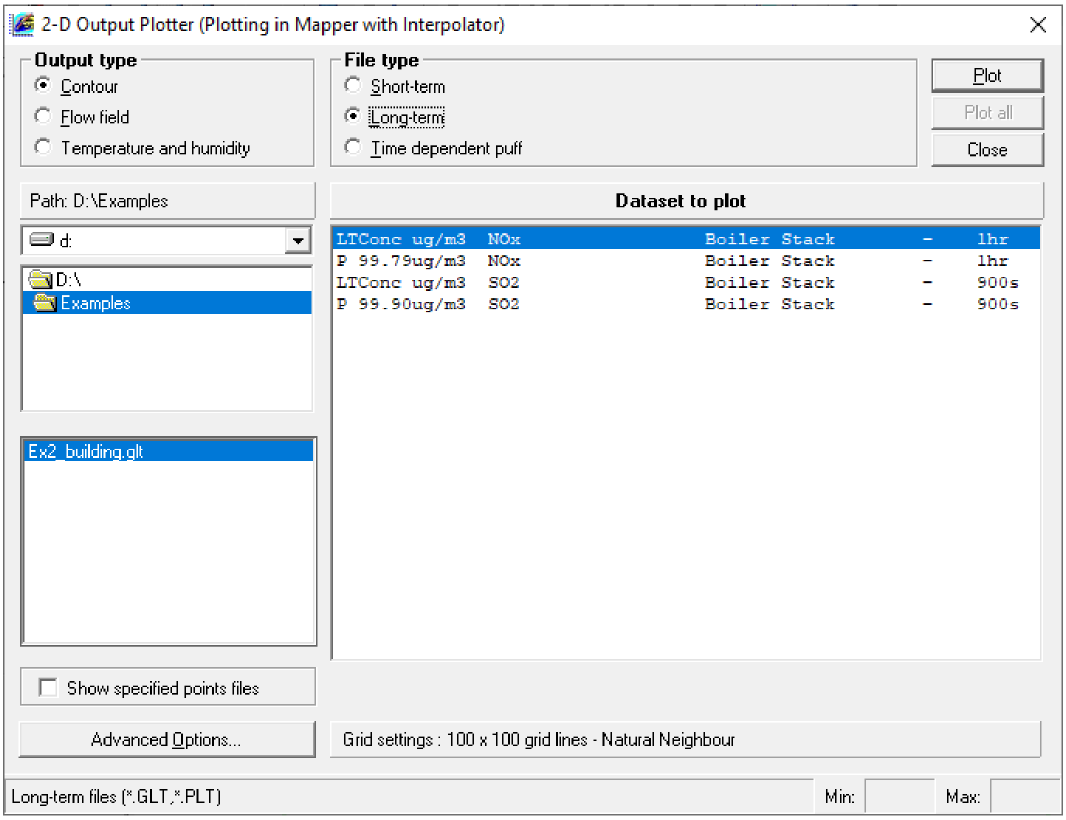


Figure 8.23 – Example 2: the **2-D Output Plotter** screen.

For the purposes of illustration, suppose this were an *annual* average concentration. Assuming all the NO_X consisted of NO_2, it would then be compared to the NAQS annual mean limit of 40 µg/m^3 NO_2.

The 99.79th percentile plot shows that the 99.79th percentiles of hourly means are much higher than the daily average concentrations at each grid point. If it were for a whole year, then the maximum calculated value of about 120 µg/m^3 would be compared to the NAQS limit of 200 µg/m^3.

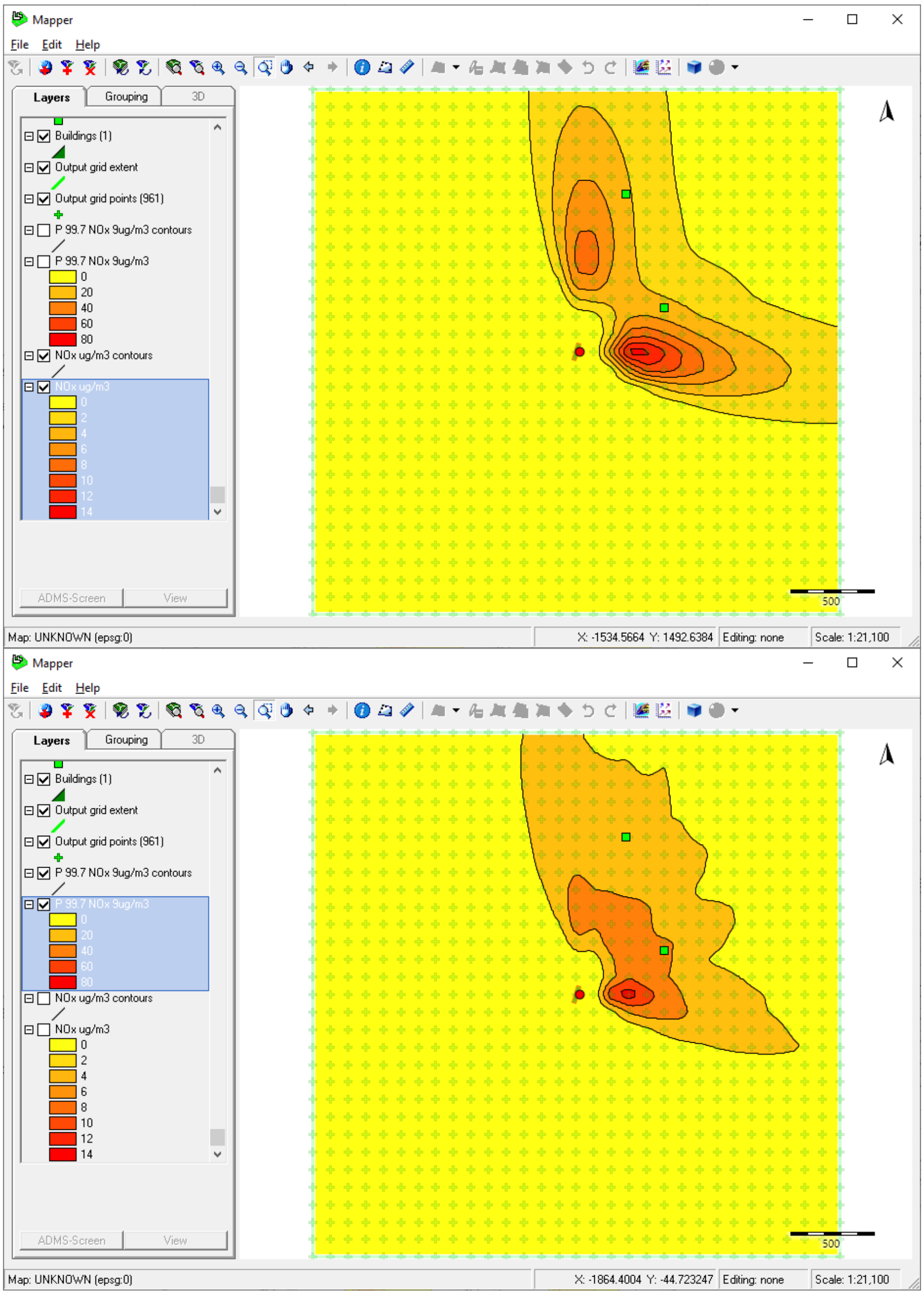


Figure 8.24 − Example 2: contour plots in the Mapper for NO_X. Long-term average (top) and 99.79th percentile of hourly concentrations (bottom).

Look at the long-term SO_2 results in the same way as NO_X. In this case if the run were for a year or more of meteorological data, the percentile results would be comparable with the NAQS limit of 270 $\mu g/m^3$ for the 15-minute average concentrations.

8.2.3 Viewing numerical results

The results can be viewed numerically. Select the **Results**, **Numerical output** menu command at the top of the interface. This will open a dialogue box, select *Ex2_building.plt* and click **Open**. There are 8 columns of data, the first few of which are shown in **Figure 8.25**. To view the additional columns, use the scroll bar at the bottom of the screen. The first four columns contain the name, X, Y and Z coordinates of each specified point. The remaining columns contain the calculated average concentrations of NO_x and SO_2, plus the requested percentile values.

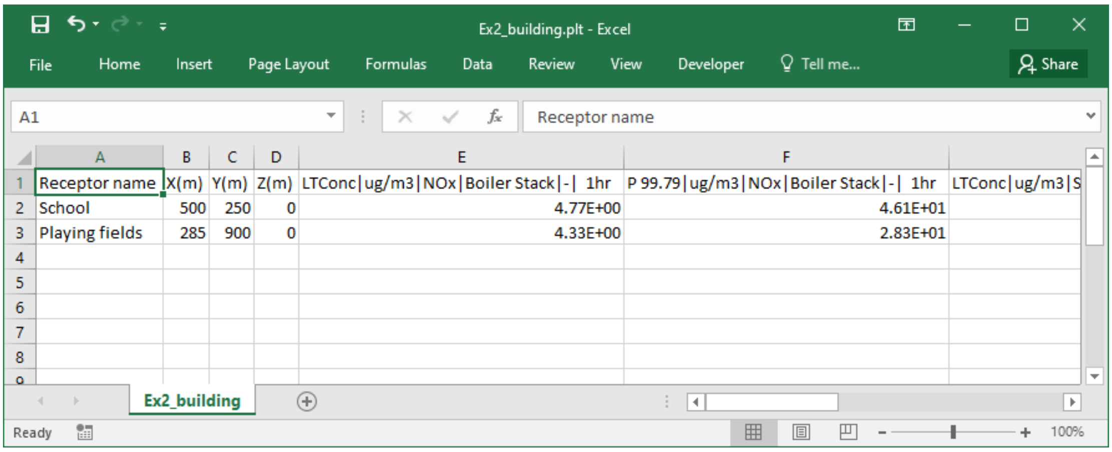


Figure 8.25 − Example 2: the *Ex2_building.plt* file viewed in Microsoft Excel.

8.3 Data files supplied with ADMS-Screen

This final section lists some of the files to be found in the *<install_path>\Examples* and *<install_path>\Data* directories supplied with the model. Note that ADMS 6 and ADMS-Screen share an install and so have the same data and example files installed. As such, not all the supplied example files are relevant to ADMS-Screen.

These files are principally *.apl* and *.met* files.

A short description of the files supplied in *<install_path>\Examples* that may be relevant to ADMS-Screen users is given in **Table 8.1**. Those supplied in *<install_path>\Data* are described in **Table 8.2**.

File name	Description
Build.apl	Short-term run including building effects
OneDay.apl	Long-term run using one day of hourly sequential data
Rolling.apl	Short-term run with different averaging times, including rolling averages
Stack.apl	Short-term run with one point source (basic)
Ex_dat.dat	Example US NOAA/NCDC meteorological data input file for the ADMS-Screen **Convert Met. Data** utility (described in Section 7.4)
Ex_dat.met	Example converted meteorological data file produced by converting *Ex_dat.dat* with the ADMS-Screen **Convert Met. Data** utility (described in Section 7.4)
Ex_sfc.sfc	Example US AERMOD surface meteorological data input file for the ADMS-Screen **Convert Met. Data** utility (described in Section 7.4)
Ex_sfc.met	Example converted meteorological data file produced by converting *Ex_sfc.sf* with the ADMS-Screen **Convert Met. Data** utility (described in Section 7.4)

Table 8.1 − Example files in the directory *<install_path>\Examples*

File name	Description
ONEDAY.FSL	Example upper air file corresponding to *ONEDAY.MET*
270DEMO.MET	Example meteorological data file with westerly wind direction
ANNSTAT.MET	Example statistical meteorological data file with one year of data
CONVEC.MET	Example meteorological file for unstable (convective) conditions
METDEMO.MET	Example meteorological file with explanatory notes of the meteorological data
NEUTRAL.MET	Example meteorological file for neutral conditions
NSC.MET	Example meteorological file with convective, neutral and stable conditions (3 lines only)
ONEDAY.MET	Example meteorological file with one day of hourly sequential data
R91A-G.MET	Meteorological file with data approximately equivalent to the Pasquill-Gifford (R91) stability categories A to G (7 lines)
STAT.MET	Example statistical meteorological data file with data representing 120 days
Ss79r.tfw	World file for *Ss79r.tif*
Ss79r.tif	Example background map file
Ss79r.tif.prj	Coordinate projection file for *Ss79r.tif*
*OpenStreetMaps *.ttkwp*	Example Web Map Service files using Open Street Maps
OpenStreetMaps Global WMS URL.txt	Example URL to Add WMS layer using Open Street Maps Global WMS service

Table 8.2 − Example data files in the directory *<install_path>\Data*.

SECTION 9 Technical Summary

This section is intended to provide a summary of the mathematical and physical background to ADMS-Screen, and is essentially an abbreviated form of the Technical Specification documentation (CERC, 2023), to which readers should refer for full details.

9.1 Meteorological input and output

Section 3.3 describes the types of meteorological data that can be input to ADMS-Screen. For all the data types, each line of input data describes the meteorological conditions for one or more hours, the conditions being assumed to be fixed for any given hour. The meteorology input module reads the data and calculates values of the various meteorological quantities required for running the dispersion model.

Data may be in the form of a chronological record, which is termed *hourly sequential*. Other data may have a certain weight or frequency associated with each line of meteorological data. Such data are usually non-chronological and are termed *statistical* as they have been statistically analysed. It is also possible that the data are neither sequential nor statistical, but some more general collection of one or more meteorological conditions.

9.1.1 Input

The meteorological input dataset can contain a variety of meteorological parameters.

The complete list of possible input variables is shown in **Table 9.1**. The first three columns are alternative forms of the variable names that may be used in creating meteorological data files. As ADMS-Screen matches the name to identify a variable the user may want to use short versions of the variable names (columns 1 and 3) in order to avoid making errors in typing. Names from different lists may be used in the same meteorological input file, e.g. using U for wind speed and CLOUD for cloud cover in the same file is acceptable. The fourth column shows the units in which the data should be entered, the fifth and sixth columns show the minimum and maximum values for the data and the seventh column shows whether the variable can be interpolated (see Section 3.3.5).

It is likely that the two most common types of input data will be: sequential data (or data for a single hour) with wind speed, direction, cloud cover, time of day, time of year, temperature and possibly precipitation and sea surface temperature; or statistical data, comprising wind speed, direction, surface sensible heat flux, boundary layer height (or depth) and precipitation. Such data are supplied by the Met Office for the main UK met. stations.

Note that the Pasquill-Gifford stability categories cannot be directly input into the model (although values of U, ϕ, L_{mo} and h may be), nor are they output. In ADMS-Screen the boundary structure is characterised by the two parameters, h and L_{MO}. Values of these parameters corresponding *approximately* to the Pasquill-Gifford categories are shown in the data file *r91a-g.met* and in **Table 9.2**.

Short name	Long name	Abbreviated name	Units	Min value	Max Value	Can Interpolate?*
WIND SPEED	WIND SPEED	U	m/s	0.0	100.0	R
UG/USTAR	GEOSTROPHIC WIND SPEED/FRICTION VELOCITY	UGSTAR	-	5.0	1000.0	N
WIND DIRN	WIND DIRECTION (DEGREES)	PHI	°	0.0	360.0	R
DIRN CHANGE	GEOSTROPHIC MINUS SURFACE WIND DIRECTION (DEGREES)	DELTAPHI	°	-60.0	60.0	N
HEAT FLUX	SENSIBLE HEAT FLUX	FTHETA0	W/m^2	-200.0	1000.0	N
1/LMO	1/MONIN-OBUKHOV LENGTH	RECIPLMO	m^{-1}	-10.0	10.0	N
BL DEPTH	BOUNDARY LAYER DEPTH	H	m	40.0	4000.0	N
CLOUD	CLOUD AMOUNT (OKTAS)	CL	oktas	0.0	8.0	R
SOLAR RAD	INCOMING SOLAR RADIATION	SOLAR RAD	W/m^2	0.0	1500.0	N
TEMPERATURE	TEMPERATURE (C)	T0C	°C	-100.0	60.0	Y
N ABOVE BL	BUOYANCY FREQUENCY ABOVE BOUNDARY LAYER	NU	s^{-1}	0.0	0.1	Y
DELTA THETA	TEMPERATURE JUMP ACROSS BOUNDARY LAYER TOP	DELTATHETA	°C	0.0	25.0	N
PRECIP	PRECIPITATION RATE (MM/HOUR)	P	mm/h	0.0	500.0	Y
SEA TEMP	SEA SURFACE TEMPERATURE (C)	TSEA	°C	-10.0	40.0	Y
DELTA T	TEMPERATURE OVER LAND MINUS SEA SURFACE TEMPERATURE	DELTAT	°C	-40.0	40.0	Y
SIGMA THETA	SIGMA THETA (DEGREES)	SIGMATHETA	°	0.0	90.0	Y
S HUMIDITY	SPECIFIC HUMIDITY	S HUMIDITY	kg/kg	0.0	0.1	Y
R HUMIDITY	RELATIVE HUMIDITY (PERCENT)	RHUM	%	0.0	100.0**	Y
RH ABOVE BL	RELATIVE HUMIDITY ABOVE BOUNDARY LAYER (PERCENT)	RH ABOVE BL	%	0.0	100.0	Y
DRH/DZ	D(RELATIVE HUMIDITY)/DZ ABOVE BOUNDARY LAYER (PERCENT/M)	DRH/DZ	%/m	-10.0	10.0	N
LAT HT FLUX	LATENT HEAT FLUX	LAT HT FLUX	W/m^2	-100.0	1000.0	N
Z0 (M)	ROUGHNESS LENGTH (MET SITE)	Z0 (M)	m	1.0×10^{-10}	100.0	Y
Z0 (D)	ROUGHNESS LENGTH (DISPERSION AREA)	Z0 (D)	m	1.0×10^{-10}	100.0	Y
ALBEDO (M)	ALBEDO (MET SITE)	R	-	0.0	1.0	Y
ALBEDO (D)	ALBEDO (DISPERSION AREA)	ALBEDO (D)	-	0.0	1.0	Y
ALPHA (M)	MODIFIED PRIESTLEY-TAYLOR PARAMETER (MET SITE)	ALPHA	-	0.0	3.0	Y
ALPHA (D)	MODIFIED PRIESTLEY-TAYLOR PARAMETER (DISPERSION AREA)	ALPHA (D)	-	0.0	3.0	Y
HOUR	HOUR	THOUR	-	0	24	R
DAY	DAY	TDAY	-	1	366	R
YEAR	YEAR	YEAR	-	1900	2500	R
FREQUENCY	FREQUENCY	FR	-	0	-	N
FREQUENCY FOR MONTHS xx TO xx, HOURS xxxxx TO xxxxx	FREQUENCY FOR MONTHS xx TO xx, HOURS xxxxx TO xxxxx (GMT + xxxxx)	MONTHS xx TO xx, HOURS xx TO xx	-	-	-	N

Table 9.1 − Variables that may be input into the meteorological input module. *Key for interpolation indicator: R = Required for interpolation, Y = interpolatable, N = not interpolatable. ** Relative humidity values up to 120% can be entered via a *.met* file, but will be taken as 100%.

There is no exact correspondence between the boundary layer parameters (h, L_{MO}) and the Pasquill-Gifford categories since many different values of h and L_{MO} may correspond to one Pasquill-Gifford category.

Stability: Stable $h/L_{MO} > 1$
Neutral $-0.3 \leq h/L_{MO} \leq 1$
Convective $h/L_{MO} < -0.3$

U (m/s)	L_{MO} (m)	$1/L_{MO}$ (m^{-1})	h (m)	h/L_{MO}	P-G Category
1	-2	-0.5	1300	-650	A
2	-10	-0.1	900	-90	B
5	-100	-0.01	850	-8.5	C
5	∞	0	800	0	D
3	100	0.01	400	4	E
2	20	0.05	100	5	F
1	5	0.2	100	20	G

Table 9.2 − Values of wind speed, Monin-Obukhov length (L_{MO}) and boundary layer height (h), which may be used to represent Pasquill-Gifford categories A-G.

The minimum requirement for meteorological data (for the model to run) is:

- wind speed (this would normally be a near surface wind, but could be a geostrophic wind or friction velocity – in each case the height of wind must be entered, which would typically be 10 m for the near-surface case and should be 1000 m and 0 m for the geostrophic and friction velocity cases, respectively),
- wind direction,

plus *one* of the following:

- reciprocal of Monin-Obukhov length,
- surface sensible heat flux,
- cloud cover, time of day and time of year.

With regard to the latter three parameters, if more than one of these is supplied, they are used in order of preference in the order they are listed above. That is, if the reciprocal of Monin-Obukhov length is specified it will be used, otherwise the surface sensible heat flux will be used. If neither the reciprocal of Monin-Obukhov length nor the surface sensible heat flux are specified then the cloud cover, time of day and time of year will be used.

If cloud cover, time of day and time of year are the *only* data specified, then it is advisable to add temperature and boundary layer height, if a good estimate is known, to the variables in the *.met* file. If the boundary layer height is not known, the estimate for a particular hour will be improved if meteorological data for all the hours from midnight are included, as the ADMS-Screen scheme uses this information from previous hours to improve the estimate.

It is preferable to include cloud cover data if available. However, if unavailable, incoming solar radiation may be specified instead. Incoming solar radiation is measured by a radiometer at ground level, although check with the manufacturer exactly what is measured.

In general, the boundary layer height should always be entered if you think you can provide a better estimate than the meteorological input module. The module will provide a good estimate when the site is in mid latitudes, e.g. UK, and it is either

1. day time with sequential data stretching back at least to dawn, *or*
2. night time.

If however, neither 1 nor 2 apply and you do *not* have information about the boundary layer height, then it is advisable to provide as much information as you have available (e.g. all five of the above meteorological parameters). This may help the model to estimate boundary layer height by enabling it to estimate the values of heat flux occurring prior to the hour currently under consideration. In addition, specifying temperature may also help to improve the module's estimate of the boundary layer height.

Additional meteorological input data that may be required are:

- frequencies with which particular meteorological conditions occur, if the meteorological data are statistical.

Note that ADMS-Screen does not model calm conditions. Any lines of meteorological data for which the wind speed at 10 m is calm (less than 0.75 m/s) will be skipped by the model, and output will be given as -999 for that line of meteorological data.

Further input parameters

In addition to the data in the meteorological input data set, the module also requires certain data that are provided via the interface. These are:

- surface roughness,
- height of recorded wind, i.e. the height above ground at which the wind measurements were made (usually 10 m),
- whether the meteorological data are hourly sequential,
- whether the wind direction data are in sectors, and if so, the sector size. Wind direction data are often recorded to the nearest 10°, 22.5° or 30°. Inputting the appropriate sector size allows the model to account for the approximation in the wind direction. For small sector sizes (less than 15°) the model will use one of three equally spaced wind directions within the sector. For example, if the data are in 10° sectors, and the wind direction in the meteorological data file is given as 30°, the model will use 26.7°, 30° or 33.3°. For large sector sizes (greater than 15°), the model will carry out calculations for all of 5 equally spaced wind directions within the sector. The results for all wind directions are given equal weighting in the concentration calculations. For example, if the data are in 30° sectors and the wind direction in the meteorological data file is given as 30°, the model will use 18°, 24°, 30°, 36° and 42°. If the data are not in sectors, the wind direction is used exactly as given in the meteorological data file.

Further optional parameters may also be specified via the interface. These include a minimum value of L_{MO} (for urban areas) and values of Priestley-Taylor parameter and surface albedo.

If the met. site is distant from the area of dispersion, the meteorological input module includes the option to modify the wind profile at the source by taking account of the surface roughness both at the met. site and the source. Different values of surface albedo, Priestley-Taylor parameter and minimum value of L_{MO} at the met. site and dispersion site may also be entered. It is also possible to enter a precipitation factor to account for differences in rainfall between the sites (see Section 4.2).

9.1.2 Meteorological data pre-processing

The meteorological input module is called once for each hour's data and uses standard algorithms to calculate the boundary layer meteorological parameters required by the dispersion model. Full details can be found in Holtslag and van Ulden (1983) and the ADMS Technical Specification (CERC, 2023).

In addition to processing the data, the module checks that the input data are plausible, i.e. that they lie within certain limits. While it is running, messages may be provided giving warnings and notification of errors. Where an error occurs which prevents calculations being done for that particular line, output for that line will be given as –999.

9.1.3 Output

The variables output by the meteorological input module are listed in **Table 9.3**.

Variable	Description
u_*	Friction velocity (m/s)
U_g	Geostrophic wind speed (m/s)
U_g^*	Geostrophic wind speed normalised by the friction velocity
ϕ_0	Surface wind direction (angle from which wind blows in degrees measured clockwise from north, e.g. 270° is a westerly wind) (°)
ϕ_g	Geostrophic wind direction (angle from which wind blows in degrees measured clockwise from north) (°)
$\Delta\phi$	Geostrophic wind direction minus surface wind direction (°)
ϕ	Wind direction (as obtained from the meteorological input data) (°)
ϕ_{sec}	Wind direction used by the model for this meteorological data line for long-term calculations, which may differ from the input value if the data are in sectors (°)
w_*	Convective velocity scale (if $F_{\theta_0} > 0$, $w_* = (g F_{\theta_0} h/\rho c_p T_0)^{1/3}$; if $F_{\theta_0} \le 0$, $w_* = 0$) (m/s)
F_{θ_0}	Surface heat flux (W/m^2)
K	Incoming solar radiation (W/m^2)
$1/L_{MO}$	Reciprocal of the Monin-Obukhov length (m^{-1})
h	Boundary layer height (m)
N_u	Buoyancy frequency above the boundary layer (s^{-1})
$\Delta\theta$	Temperature jump across the boundary layer top (K)
T_0^c	Near-surface temperature (°C)
P	Precipitation rate (mm/h)
ΔT	Near-surface temperature over land minus sea surface temperature (°C)
σ_θ	Standard deviation of mean wind direction (°)
q_0	Surface specific humidity (kg/kg)
λ_E	Surface latent heat flux (W/m^2)
RH_u	Relative humidity just above the boundary layer (%)
$d(RH_u)/dz$	Relative humidity lapse rate above the boundary layer (%/m)

Table 9.3 − Output variables from the meteorological input module.

The variables P, ΔT, q_0, λ_E, RH_u and $d(RH_u)/dz$ may be missing if insufficient input data are given. The processed met. module data are available for use by the other modules, in particular the boundary layer structure module.

9.1.4 Limitations

In calculating the boundary layer parameters, it is assumed that the boundary layer is self similar for a given value of h/L_{MO}. However, users of the model should be aware that there are some situations, such as latitudes near the equator or the poles, where this approximation can lead to significant errors. Full details are given in the ADMS Technical Specification (CERC, 2023).

9.2 Parameterisation of the boundary layer

In ADMS-Screen the boundary layer is characterised by the boundary layer height h and the Monin-Obukhov length L_{MO} and **not** by a Pasquill-Gifford stability category.

The Monin-Obukhov length is defined as

(9.1)
$$L_{MO} = \frac{-u_*^3}{\left(\dfrac{\kappa g F_{\vartheta 0}}{\rho c_p T_0}\right)}$$

in which u_* is the friction velocity at the Earth's surface, κ is the von Karman constant (0.4), g is the acceleration due to gravity, $F_{\theta 0}$ is the surface sensible heat flux, ρ and c_p are, respectively, the density and specific heat capacity of air and T_0 is the near-surface temperature.

In unstable or convective conditions, the Monin-Obukhov length is negative. The magnitude of the length is then a measure of the height above which convective turbulence, i.e. turbulent motions caused by thermal convection, is more important than mechanical turbulence, i.e. turbulence generated by friction at the Earth's surface.

In stable conditions, the Monin-Obukhov length is positive. It is then a measure of the height above which vertical turbulent motion is significantly inhibited by the stable stratification.

Figure 9.1 shows the different regions of the boundary layer in terms of the parameters h/L_{MO} and z/h where z is height above the ground. **Figure 9.2** shows the same information but with a dimensional vertical scale, z.

In the different regions of the boundary layer different mechanisms are important in generating turbulence. These are:

1. surface heating leading to convectively generated turbulence (the convective eddies increase in energy as they rise through the boundary layer),
2. shear at the surface leading to mechanically generated turbulence,
3. local shear, for instance at the top of the boundary layer, that can be a weak source of turbulence.

This approach to boundary layer stability, whereby the boundary layer structure is defined in terms of two variables (z/L_{MO} and z/h), supersedes the Pasquill-Gifford formulation, and differs crucially from the Pasquill formulation in allowing the variation of boundary layer properties with height to be included. However, it is difficult to make exact comparisons between the two schemes.

Figures 9.1 and **9.2** show Pasquill-Gifford stability categories corresponding *approximately* to ranges of h/L_{MO}. Note that, particularly in stable meteorological conditions, the Pasquill class is not a simple function of h/L_{MO}.

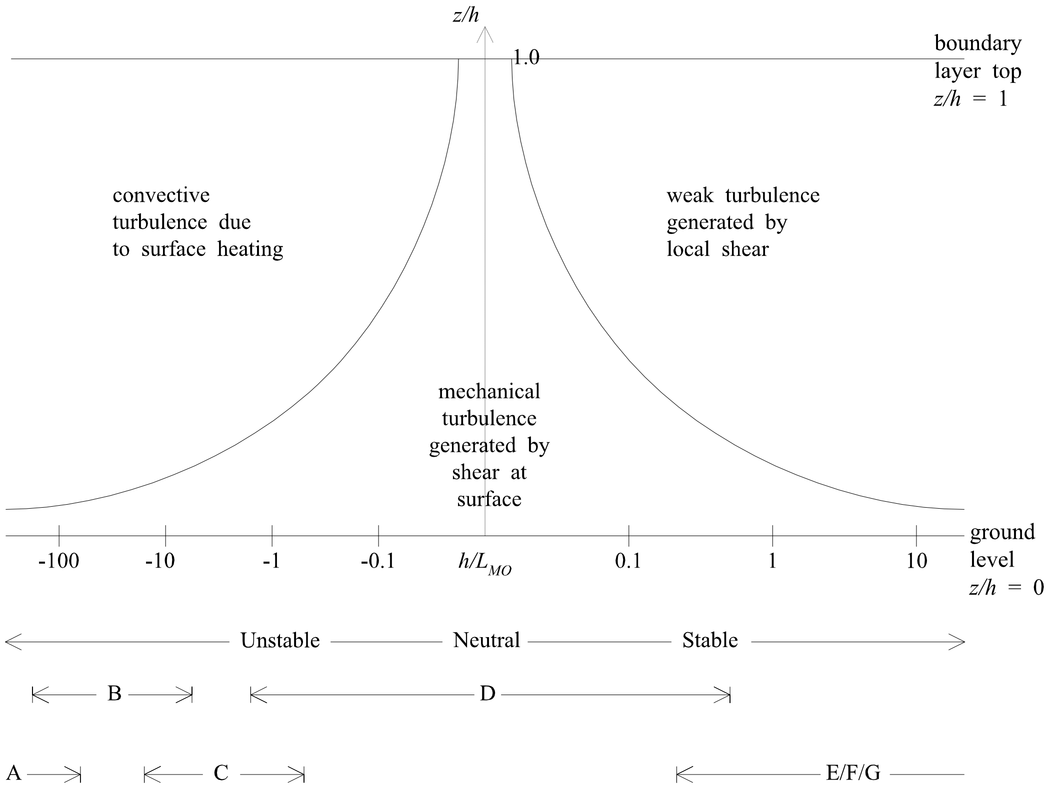


Figure 9.1 – Non-dimensional schematic representation of variation of Monin-Obukhov length with atmospheric stability.

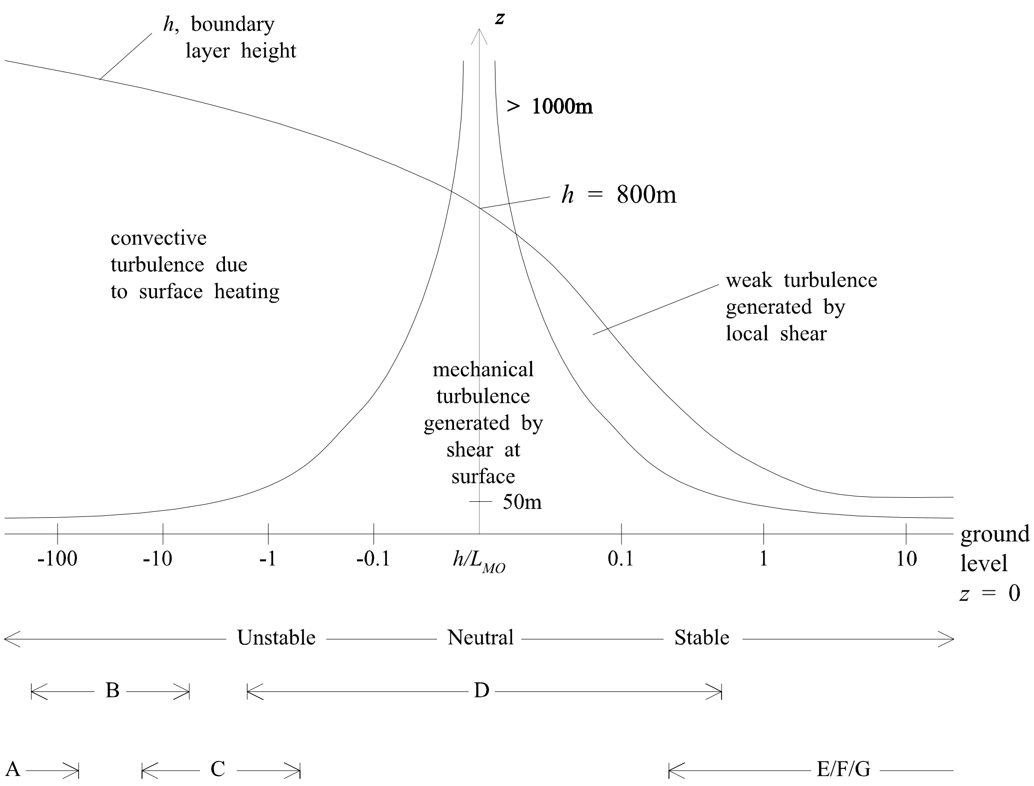


Figure 9.2 – Dimensional schematic representation of variation of Monin-Obukhov length with atmospheric stability.

9.2.1 Boundary layer structure

ADMS-Screen calculates the boundary layer variables listed in **Table 9.4** at different heights. Vertical profiles are expressed as functions of z/L_{MO} and z/h and have been derived from experimental data (Caughey and Palmer, 1979; van Ulden and Holtslag, 1985; Hunt *et al*., 1988d). For full details of these profiles see the ADMS Technical Specification (CERC, 2023). These variables are used, in turn, by other modules. These variables are used, in turn, by other modules.

Variable	Description
$U(z)$, $\frac{dU}{dz}$, $\frac{d^2U}{dz^2}$	Mean wind speed (m/s) and its first (s^{-1}) and second derivatives ($m^{-1}s^{-1}$) with height
$\sigma_u(z)$, $\sigma_v(z)$, $\sigma_w(z)$	Root-mean-square turbulent velocities (m/s)
$\Lambda_v(z)$, $\Lambda_w(z)$	Turbulent length scales (m)
$\varepsilon(z)$	Energy dissipation rate (m^2/s^3)
$T_L(z)$	Lagrangian time scale (s)
$N(z)$	Buoyancy frequency (s^{-1})
$T(z)$	Temperature (K)
$\rho(z)$	Density (kg/m^3)
$P(z)$	Pressure (mbar)

Table 9.4 − Boundary layer variables calculated by ADMS-Screen.

Note that the plume spread parameters σ_y and σ_z are calculated using these boundary layer variables and hence vary with source height and plume height. This contrasts with the approach adopted in models using Pasquill categories, in which values of σ_y and σ_z are obtained from measurements and are independent of plume height.

Turbulent velocities σ_u, σ_v and σ_w are subject to a minimum value of turbulence that ranges between 0.01 and 0.2 m/s, depending on the user-input minimum value of L_{MO}. This accounts for the fact that in urban areas (high minimum L_{MO}), where conditions never become very stable, there will always be some turbulence.

9.3 Dispersion

9.3.1 Dispersion parameters

Field experiments and research have shown that the dispersion parameters σ_y and σ_z vary with downwind distance from a point source in a way that depends on the atmospheric boundary layer height (h), the height of the source (z_s) and the height of the plume as it travels downwind. For reviews of this subject, see Hunt *et al*. (1988a), Hanna and Paine (1989) and Weil (1985). This approach is in contrast to older methods, described in the NRPB report R91 (Clarke, 1979) and used in the model ISC (U.S. E.P.A., 1995), in which the effect of the source height is not taken into account when calculating the width and depth of the plume.

There is no general theory or even generally accepted semi-empirical expression that describes the dispersion from a source at all heights within the boundary layer ($0 < z_s < h$), in all conditions of atmospheric stability, and over the complete range of distances from the source to about 30 km downwind. In developing ADMS-Screen the approach adopted has been first to use formulae that have been developed and broadly accepted for specific ranges of the parameters z_s/h, h/L_{MO} (stability) and x/h (downwind distance). Interpolation formulae have then been constructed to cover the complete parameter range. The basis for these formulae is set out at length in the report by Hunt *et al*. (1988a).

9.3.2 Stable and neutral boundary layers

All the turbulence in the stable boundary layer is mechanically generated, i.e. there is no generation of turbulence due to convective motions. Usually, the level of turbulence decreases with height, as the relative importance of stratification increases, although it can be enhanced by wave motions at the top of the boundary layer. (The effect of such wave motions is not considered by ADMS-Screen.)

Concentration distribution

The profile of the concentration distribution is Gaussian with reflections at the ground, and at the top of the boundary layer, if there is an inversion (i.e. sharp increase in temperature with height) at the top of the boundary layer. It is assumed that an inversion is present if conditions are neutral or convective, or if the meteorological pre-processor predicts an inversion. If there is no inversion, the final three terms in the brackets in Equation (9.2), which represent reflections at the top of the boundary layer, are not included.

(9.2)
$$C = \frac{Q_s}{2\pi \sigma_y \sigma_z U} e^{-y^2/2\sigma_y^2} \times \left(e^{-(z-z_s)^2/2\sigma_z^2} + e^{-(z+z_s)^2/2\sigma_z^2} + e^{-(z+2h-z_s)^2/2\sigma_z^2} + e^{-(z-2h+z_s)^2/2\sigma_z^2} + e^{-(z-2h-z_s)^2/2\sigma_z^2} \right)$$

Spread parameters

The vertical dispersion parameter (σ_z) at the mean height of the plume (z_m) is linked directly to the vertical component of turbulence (σ_w) and the travel time from the source (t) by the relationship

(9.3) $$\sigma_z = \sigma_w t \left(\frac{1}{b^2} + \frac{N^2 t^2}{1 + 2Nt} \right)^{-1/2}$$

where N and σ_w are the buoyancy frequency and root-mean-square vertical turbulent velocity at z_m, respectively (Weil, 1985; Hunt, 1985). The factor b is a function of z_s/h and ensures a smooth transition between the solution for surface releases and elevated releases.

The transverse dispersion parameter (σ_y) is given by

(9.4) $$\sigma_y^2 = \sigma_{yt}^2 + \sigma_{yw}^2$$

The spreading due to turbulence (σ_{yt}) is expressed as:

(9.5) $$\sigma_{yt} = \sigma_v t \left(1 + \sqrt[3]{15.6} \frac{u_* t}{h} \right)^{-1/2}$$

with u_* the friction velocity at the Earth's surface and σ_v the root-mean-square crosswind turbulent velocity crosswind.

The spread due to variations in mean wind direction (σ_{yw}) is equal to $\sigma_\theta x$. The parameter σ_θ is the standard deviation of the mean wind direction. This may either be specified as a measured meteorological input parameter in degrees, or estimated by the meteorological data pre-processor using the following expression:

(9.6) $$\sigma_\theta = 0.065 \sqrt{\frac{7T}{U_{10}}}$$

Here T is the averaging time in hours and U_{10} is the mean wind speed at height 10 m.

Near-field to far-field transition

In the presence of an inversion, the part of the plume that does not have sufficient momentum or buoyancy to penetrate the top of the boundary layer is effectively confined within the boundary layer, because material reaching the top of the layer is reflected downwards. Sufficiently far from the source, after parts of the plume have been reflected at the ground and at the top of the boundary layer, the vertical variation in concentration of the pollutant is so small as to be negligible. This occurs at the downwind distance where $\sigma_z = 1.5\ h$). Downwind of this point the plume is considered to grow horizontally as a vertical wedge as if from a uniform vertical line source extending from 0 to h, rather than as a cone, so the variation with z in equation (9.2) is ignored.

9.3.3 Convective boundary layer

Field experiments of diffusion from elevated sources in the convective boundary layer (Briggs, 1985) have confirmed earlier laboratory and computational studies (Lamb, 1982) that the form of the vertical profiles of concentration are skewed and significantly non-Gaussian, thus changing the profile of concentration compared with an assumed Gaussian distribution. Near the ground this is important for modelling processes such as wet or dry deposition. It is also very important for evaluating maximum ground-level concentrations from elevated releases. Ignoring the non-Gaussian distribution can lead to under-estimates of ground-level concentration from elevated sources. Models that use non-Gaussian profiles are referred to as "new generation" models. New generation models include the Hybrid Plume Diffusion Model (HPDM) of Hanna and Paine (1989), the Almanac code of National Power (Moore and Lee, 1982), the CTDM code of the U.S. E.P.A. (Perry, 1991) and AERMOD (Cimorelli *et al*., 2004).

Concentration distribution

In the convective boundary layer (CBL) the probability distribution of the vertical velocity and, hence, the concentration distribution is **non-Gaussian**, or skewed. The non-Gaussian distribution ensures that, for elevated sources, the height within the plume at which the concentration is a maximum descends as the plume moves downwind, while the plume mean height ascends. After the height of the maximum concentration reaches the ground it can rise again.

Spread parameters

The transverse dispersion parameter (σ_y) is calculated in three parts, the first for dispersion due to convection (σ_{yc}), the second due to mechanically driven turbulence (σ_{yn}), and the third ($\sigma_{yw} = \sigma_\theta x$) is included to allow for the variation in the wind direction:

(9.7) $$\sigma_{yc} = \sigma_{vc}\, t \left(1 + \frac{t}{h}\sqrt[3]{0.75 w_*}\right)^{-1/2}$$

(9.8) $$\sigma_{yn} = \sigma_{vn}\, t \left(1 + \frac{t}{h}\sqrt[3]{15.6 u_*}\right)^{-1/2}$$

σ_{vc} and σ_{vn} are the root-mean-square horizontal turbulent velocities due to convection and mechanically driven turbulence, respectively. σ_θ is as defined in equation (9.6).

The total transverse spread is therefore given by

(9.9) $$\sigma_y^2 = \sigma_{yc}^2 + \sigma_{yn}^2 + \sigma_{yw}^2$$

For the vertical spread σ_z, the skewed nature of the probability distribution function for the vertical turbulent velocity w leads to the definition of σ_{w+} and σ_{w-} for the upwards and downwards velocities, respectively. Then $\sigma_{z+} = \sigma_{w+}\, t$ and $\sigma_{z-} = \sigma_{w-}\, t$ are defined and used in the calculation of C_{CBL}. A more detailed description is given in the

ADMS Technical Specification (CERC, 2023), P10/01 & P12/01 ("Plume/puff spread and mean concentration module specifications").

The formulae above (equations (9.7) and (9.8)) reduce to forms *suitable* for neutral conditions as the meteorological conditions tend towards neutral conditions, but the actual forms are not the same as the ADMS-Screen Gaussian plume formula for the neutral boundary layer. A smooth transition from the convective boundary layer solution to the neutral boundary layer solution is used.

Near-field to far-field transition

As in stable and neutral conditions, the transition to a far-field model, where the source is equivalent to a vertical line source extending from 0 to h and of uniform strength, is assumed to occur when $\sigma_z = 1.5\ h$.

9.4 Plume rise

The plume rise module predicts the rise in trajectory and enhanced dilution of a continuous emission of gaseous material that is hot or has momentum. It takes into account the effects of plume buoyancy and momentum in generating plume rise, and includes penetration of inversions.

The underlying theory is based on an integral model, in which integral conservation equations are solved for the fluxes of mass, momentum and heat. The plume is assumed to be of circular cross-section. The plume properties such as velocity, density, etc., are uniform in any cross-section (i.e. a "top-hat" profile) but vary along the plume centreline. Entrainment of ambient air takes place due to the motion of the plume relative to its environment as well as due to atmospheric turbulence. The external velocity and temperature fields vary with height.

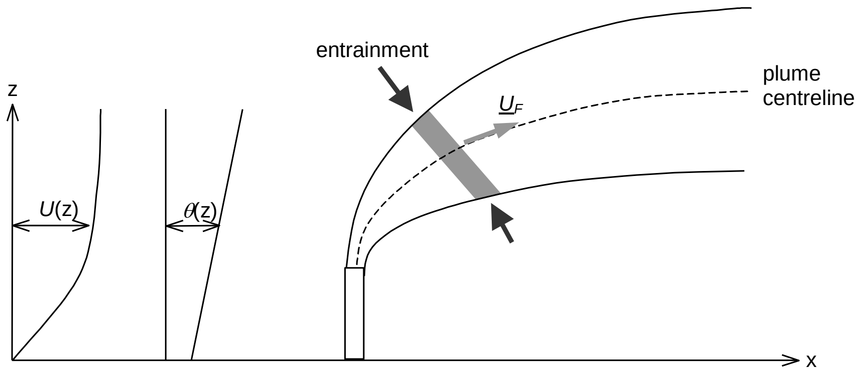


Figure 9.3 – Plume rise model.

The plume rise module is initialised from the following source conditions:

- exit diameter,
- emission velocity or volume flow rate,
- temperature or density of the release material.

The equations are then solved numerically by a Runge-Kutta numerical scheme with a variable internal time step. If plume visibility is modelled, the plume temperature and hence plume rise is affected by energy transfers relating to the moisture content.

9.4.1 Stack-induced downwash

The flow and pressure fields around a stack can influence the plume rise of the emission by reducing the mean height of the plume just downwind of the source. Only releases of relatively small upward momentum are affected, since all other emissions rise rapidly away from the zone of influence.

The algorithm used to predict stack downwash in ADMS-Screen is that used in many other models (Hanna *et al*., 1982; Snyder and Lawson, 1991) and applies to point sources only.

If the emission velocity ratio, w_S/U_H, is less than 1.5, the source height is corrected (reduced) by Δz_S, where

(9.10)
$$\Delta z_s = \begin{cases} 2\left(\dfrac{w_S}{U_H} - 1.5\right)D_S & \text{for } \dfrac{w_S}{U_H} < 1.5 \\ 0 & \text{for } \dfrac{w_S}{U_H} > 1.5 \end{cases}$$

with D_s the outside diameter of the stack, U_H the approach flow speed at the height of the stack top, w_s the emission speed, and Δz_S the correction to the stack height.

If the **Buildings** option is used, the stack downwash correction is limited to ensure that the final source location is not inside the user-defined building.

Limitations

The stack downwash algorithm is quite widely used in dispersion models although it has never been adequately validated.

9.5 Point Sources

A circular point source is specified by the location of its centre, its diameter and its height. The circle that defines the point source is assumed to lie in a horizontal plane.

Pollutant emissions are specified in g/s. A point source may emit up to 80 pollutants.

9.6 Output grids and points

'Gridded' output points defined in a horizontal plane can be specified in two different ways:

1. Cartesian grid with regularly spaced grid lines (shown in **Figure 9.4**),
2. Cartesian grid with variable spacing between the grid lines (shown in **Figure 9.4**),

With all grid types multiple output heights can be specified. Specified points can also be defined with respect to the Cartesian coordinate system. Up to 100 specified points can be defined in the interface.

The grid options apply to all types of model runs, including short-term average, long-term average, etc.

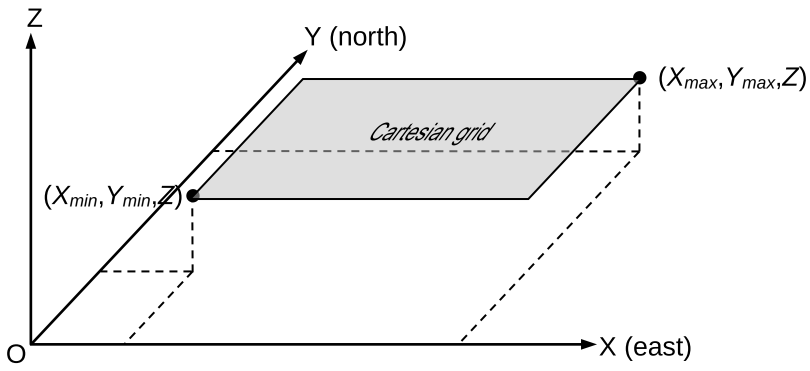


Figure 9.4 – Cartesian grids where (*X*,*Y*,*Z*) constitutes the coordinates of a point. OX is aligned due east and OY due north. Up to 51 grid lines are allowed in the X and Y directions.

9.7 Averaging times and statistics

9.7.1 Averaging times of one hour or longer

The mean concentration averaging time or sampling time (t_s) is entered for each pollutant in the **Output** screen.

If an averaging time greater than one hour is specified, it must be a whole number of hours and hourly sequential data must be supplied. The program will sum successive hourly averages to calculate the mean concentration and other statistics for the required averaging time.

The program can calculate rolling or running averages. For example, if concentrations are calculated for 24 hours of data, $\{C_i, i = 1,2,\ldots,24\}$:

- A **short-term**, 8-hour (non-rolling) average would be calculated as

  (9.11) after 8 hours of meteorological data: $C(t_s = 8\ h) = \frac{\sum_{i=1}^{8} C_i}{8}$

  (9.12) after 16 hours of meteorological data: $C(t_s = 8\ h) = \frac{\sum_{i=9}^{16} C_i}{8}$

  (9.13) after 24 hours of meteorological data: $C(t_s = 8\ h) = \frac{\sum_{i=17}^{24} C_i}{8}$

Note that the **Validity Threshold (%)** value for the pollutant, as specified in the **Output** screen, stipulates the percentage of met. lines in any given averaging period that must be valid in order for that averaging period to be considered valid.

- The **long-term**, 8-hour (non-rolling) average over this 24-h period would be

  (9.14) $$\frac{\frac{\sum_{i=1}^{8} C_i}{8} + \frac{\sum_{i=9}^{16} C_i}{8} + \frac{\sum_{i=17}^{24} C_i}{8}}{3}$$

- A **short-term** 8-hour **rolling** average would be (assuming a validity threshold of 75% and no invalid met. lines):

  (9.15)before 6 hours of meteorological data: $C(t_s = 8\ h) = no\ value$

  (9.16) after 6 hours of meteorological data: $C(t_s = 8\ h) = \frac{\sum_{i=1}^{6} C_i}{6}$

  (9.17) after 7 hours of meteorological data: $C(t_s = 8\ h) = \frac{\sum_{i=1}^{7} C_i}{7}$

  (9.18) after 8 hours of meteorological data: $C(t_s = 8\ h) = \frac{\sum_{i=1}^{8} C_i}{8}$

  (9.19) after 9 hours of meteorological data: $C(t_s = 8\ h) = \frac{\sum_{i=2}^{9} C_i}{8}$

(9.20) after 10 hours of meteorological data: $C(t_s = 8\ h) = \frac{\sum_{i=3}^{10} c_i}{8}$

etc.

- The **long-term**, 8-hour **rolling** average would be the average of the 19 calculated short-term values, i.e. the short-term rolling averages from hour 6 to hour 24.

9.7.2 Averaging times shorter than one hour

The mean concentration averaging time or sampling time (t_s) is entered for each pollutant in the **Output** screen.

Averaging times up to and including one hour are used to calculate the component of lateral plume spread due to changes in the mean wind direction, unless σ_θ (standard deviation of the horizontal wind direction) is specified as a meteorological variable (described in Section 3.3). It might be appropriate to use an averaging time shorter than one hour as a first estimate to compare with an air quality standard that has an averaging time shorter than one hour.

For averaging times greater than one hour, unless data are given by the user for σ_θ, the changes in mean wind direction within each hour of meteorological data are calculated using one hour.

9.7.3 Maximum daily output

Maximum daily output can be calculated for any averaging time. If maximum daily output is selected, for each day the maximum value of the averaging periods which end on that day is calculated (for those days for which the percentage of averaging periods that are valid is greater than the specified validity threshold).

9.7.4 Limitations

The longest period for which a rolling average can be calculated is 72 hours (3 days). The longest period for which a non-rolling average can be calculated is 168 hours (1 week).

9.7.5 Long-term statistics

Long-term averages of hourly means and percentiles can be calculated using meteorological data which have been statistically analysed and therefore have a frequency or weighting attached to each meteorological condition, or from raw data which have not been statistically analysed. The latter data may be sequential or a number of unrelated meteorological conditions (although in this case the long-term average is unlikely to be useful), so an equal frequency or weighting is attributed to each hour's data. The model outputs long-term average *mean concentrations*, long-term average *percentiles of concentration*, and long-term average *exceedences per annum*.

For each set of meteorological data and associated frequency f (normalised by dividing the sum of the frequencies so that f lies between 0 and 1), the concentration at each point is calculated, say $C(x,y,z)$. Then the long-term *mean concentration* at that point, $C_{LT}(x,y,z)$, is given by the sum of Cf over all the data sets. Note that if statistical data are used, when only the wind direction or the precipitation changes between successive lines of the meteorological data file, the calculation on the local grid is not repeated. In these cases, the numbers output to the screen corresponding to the hour's meteorological data change by more than one between each calculation of concentration.

To calculate the concentration at each point corresponding to a specified *percentile p* at ground level, say $C_p(x,y,z)$, the values of $C(x,y,z)$ at one point for each combination of meteorological variables are considered along with their frequency of occurrence f. First of all the concentration values are arranged in descending order (i.e. highest at the beginning, lowest at the end) and the values of f rearranged accordingly. Then, starting at the highest concentration, the frequencies are summed until their cumulative value is $(100 - p)/100$. Percentile calculations may require a large amount of computing time and memory space, which is largely a function of the number of meteorological data sets.

Exceedences can also be calculated. In the same way as described above for percentiles, concentrations are ordered, along with their cumulative frequency. The number of concentrations above the exceedence value under consideration are calculated and output as an equivalent value of 'exceedences per annum'.

For example, consider a run of statistical data with 120 meteorological data lines. Take one output point where concentrations are greater than the exceedence value with a frequency of 12 times. The value output at this point for this exceedence is:

$$12 \times \frac{8760}{120} = 876 \qquad (9.21)$$

If maximum daily output is selected for a long-term output, the maximum daily values are used in any percentile or exceedance calculations but not in the calculation of the long-term average. The long-term average is always the average of all of the averaging periods, so as to approximate a period average.

9.8 Buildings

The building effects module is used to calculate the dispersion of pollution from a source near large structures, up to a distance of about 60 building heights. The ADMS-Screen model of building effects has the following features.

- A single building may be defined by the user in terms of the height, length, width and orientation (the latter two parameters are disregarded for cylindrical buildings). Then, for each wind direction the building is reduced to a cuboidal effective wind-aligned building (see Section 9.8.1).
- The disturbed flow field consists of a recirculating flow region or cavity in the lee of the building, with a diminishing turbulent wake downwind.
- Concentrations of the entrained part of the plume are uniform within the well-mixed recirculating flow region and based upon the fraction of the release that is entrained.
- The concentration at a point further downwind is the sum of two contributions: a ground-level plume from the recirculating flow region and an elevated plume from the non-entrained remainder. The turbulent wake reduces plume height and increases turbulent spread.
- If the source is upwind of the building and the plume impacts the façade of the building, the plume will be split into three plumes going around and over the building. These plumes are then used in the calculation of the fraction entrained into the cavity and represent the elevated plume for the non-entrained contribution in the main wake.
- The concentration is set to zero within the user-defined building.

The building effects module interacts with the rest of ADMS-Screen, using the standard concentration profiles, but with modified plume height and plume spread. The stages in the analysis of building effects are illustrated in **Figure 9.5**. The buildings effects module definitions are shown in **Figure 9.6**

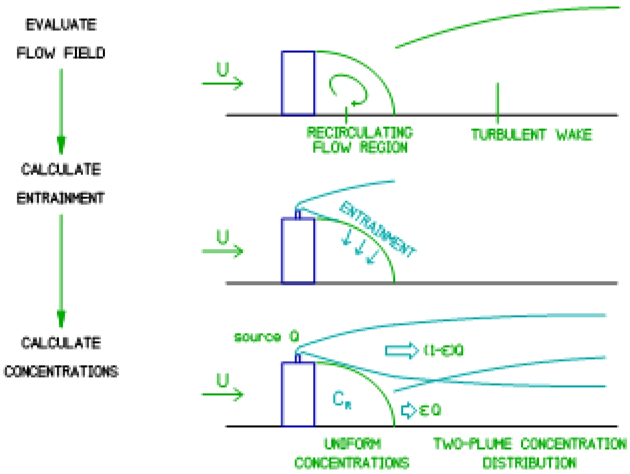


Figure 9.5 – Stages in the analysis of building effects.

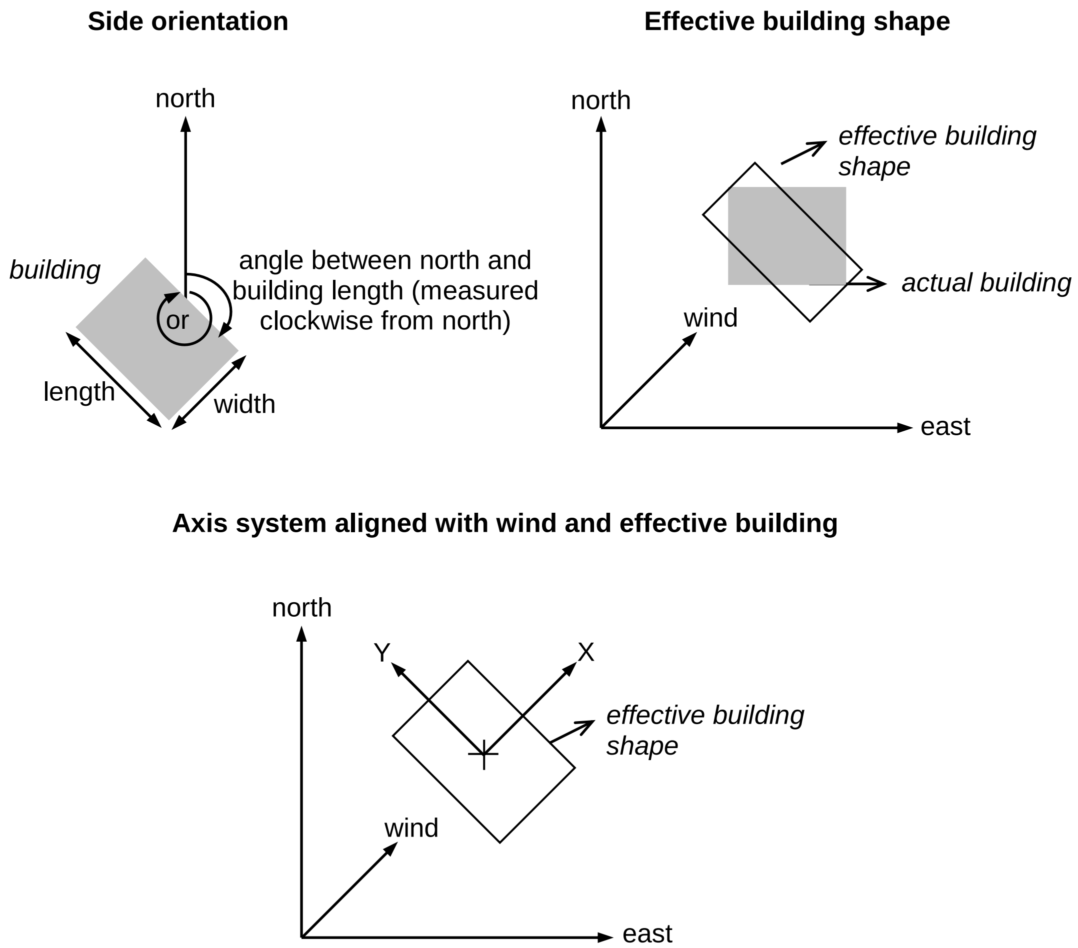


Figure 9.6 – Building effects module definitions.

9.8.1 Determination of the 'effective building'

The effective building is derived by the following algorithm:

1. Circular buildings are converted to an 'equivalent' square block, with the same centre as the input circular building and side length $D_i/\sqrt{2}$, oriented such that the wind is normal to the building face.
2. If the building height, H_B, is less than a fraction $1/\alpha$ of the source height it will not be modelled, where

   (9.22) $$\alpha = 1 + 2\min\left(1, \frac{W_B}{H_B}\right)$$

   and where W_B is the crosswind width of the building.
3. If the building is greater than a certain distance from the plume centreline in the crosswind direction it will be ignored.

   Specifically, the building will be ignored if all its vertices are greater than 0.5 $\sigma_y(|x|)$ from the plume centreline in the crosswind direction, where x is distance from the source in the alongwind direction, and $\sigma_y(x)$ is the horizontal plume spread (not including building effects) at distance *x* downwind of the source (see example in **Figure 9.7**).

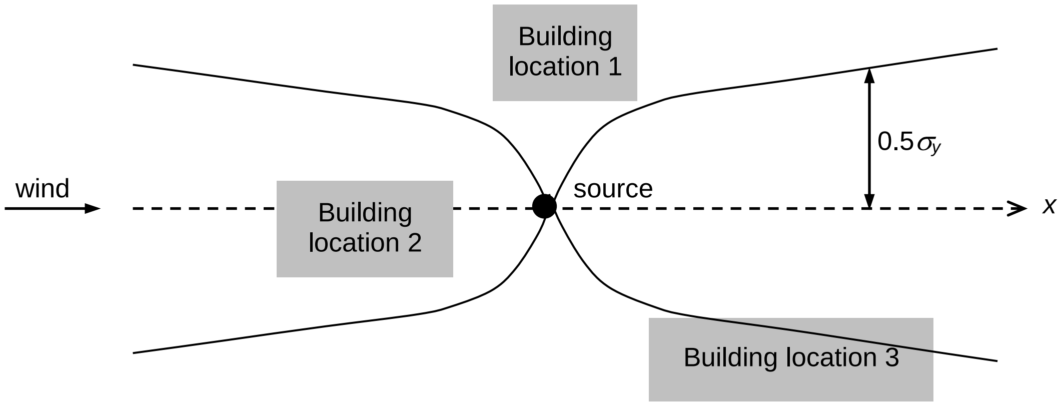


Figure 9.7 – In this example building location 2 or 3 could have an effect on dispersion, but building location 1 would not.

4. The 'orientation' of the effective building θ_B is the same as the orientation of the user-defined building. Multiples of 90° are added or subtracted until -45° < $\theta_B \leq$ 45°. Note that the effective building is always orthogonal to the flow; the 'orientation' θ_B is a parameter used to define some aspects of roof flow and near-wake behaviour.
5. The effective length of the building $L_E = min(L_F, L_D)$ where L_D is the along-wind length of the building, as seen when travelling along the wind direction, and L_F is the along-wind projection from the furthest upwind mid-face to the furthest downwind mid-face (see **Figure 9.8**).

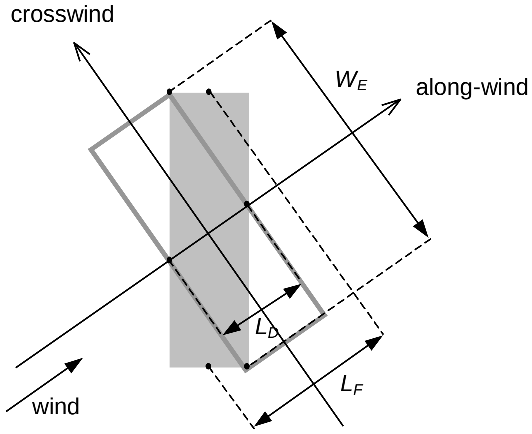


Figure 9.8 – Effective building. The grey shaded rectangle represents the user-input building and the grey open rectangle the effective building.

9.8.2 Limitations

The buildings module is based on experiments in which there was one dominant site building and several smaller surrounding buildings less important for dispersion.

9.9 Fires and flares

ADMS-Screen allows the user to enter as source efflux parameters the momentum flux F_m (m^4/s^2) and the heat release (or heat flux) F_b (MW) as alternatives to the velocity, volume flow rate or mass flux with temperature or density.

The definitions of the momentum flux F_m and the heat release F_b are those used in the HMIP D1 document (HMIP, 1993), namely

(9.23) $$F_m = Vw\frac{\rho}{\rho_a}$$

and

(9.24) $$F_b = \frac{V}{2.9}\left(\frac{\rho_a - \rho}{\rho_a}\right)$$

where the volume flux V, exit velocity w and density ρ are defined at exit conditions, i.e. the top of the fire.

If the user specifies F_m and F_b the model calculates the corresponding efflux parameters V (or w) and T (or ρ). Therefore, if V (or w) and T (or ρ) are known it may be simpler to enter them directly.

In dealing with fires, users who have some specialist knowledge of fires may find it useful to use F_m and F_b as efflux parameters since these variables may be known from experimental data in certain cases. However, users should be aware that many of the relevant factors needed to estimate F_b and F_m, such as combustion efficiency and fraction of heat radiated, are very case-specific and great care is needed when using data from a case different to the user's particular scenario.

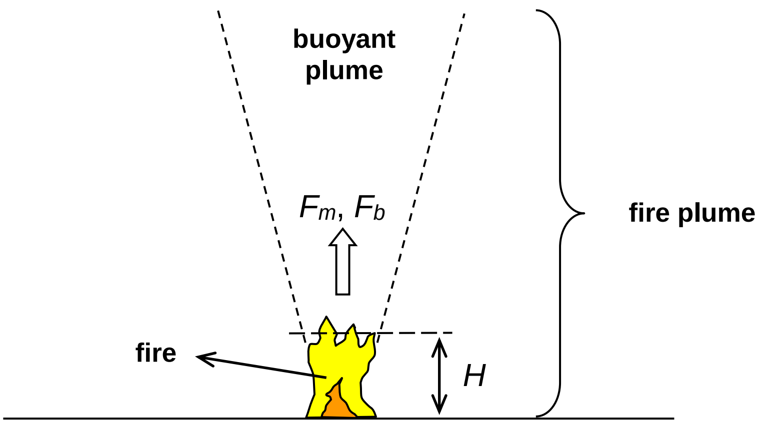


Figure 9.9 – Fire with buoyant plume. The efflux parameters may be specified in terms of pairs of parameters, such as the momentum flux F_m and the heat release F_b.

In general terms, a *fire* of the type shown schematically in **Figure 9.9**, consists of a flaming region directly above the fuel source. The fuel source may be a pool of hydrocarbon, a wooden structure, etc. Above the flaming region is a hot region, which is referred to as the *buoyant plume*. In the buoyant plume there is essentially no flame or the flame is very intermittent. Here the combustion products from the fire are carried upwards in the strong buoyant flow generated by the heat released. The combination of the fire and associated buoyant plume is sometimes referred to as the *fire plume*.

Fires may vary considerably in their configuration and a broad distinction is usually drawn between high and low momentum situations. In high momentum situations the fuel has significant vertical momentum of its own, and gives rise to a jet flame or flare, e.g. venting of gas at a refinery. In low momentum situations the fuel has no significant vertical momentum of its own e.g. it is at rest on the ground, so that the vertical momentum of the rising gases is a result of the buoyant forces acting on the hot gases, e.g. a pool fire. Note that we use the term "hot plume" even when the momentum is high and this region is initially jet-like.

ADMS-Screen cannot be applied to the flaming region itself, but may be used to model the dispersion of combustion products from the start of the buoyant plume if the data are known. The following three sections give advice on estimating the input data: source height, heat release and momentum flux.

Users should be aware that the range of behaviour exhibited by fires is very wide and so results are highly dependent on the precise details. References on fires such as Drysdale (1999) and DiNenno *et al*. (1988) may be useful. Users may also wish to refer to a pollution modelling guidance document published by the Ontario Ministry of the Environment (Lakes Environmental Consultants Inc., 2003), which describes an alternative method for deriving the effective stack height and diameter of a flare.

9.9.1 Source height

Since the hot plume begins at the top of the flame, at height H above the fuel source, the source height used in ADMS-Screen should be the sum of the flame height and the height of the fuel source. This means that an estimate of the *flame height* is required.

There are various correlations for flame height as a function of fire parameters in the literature, with no single expression applicable to all fires. However, a useful expression that is applicable for many situations (DiNenno *et al*. (1988), Section 1, Chapter 18) is

(9.25)
$$\frac{H}{D} = -1.02 + 3.7 Q_*^{2/5}$$

where D is the fire diameter and the dimensionless parameter Q_* is essentially a Froude number. Q_* is defined by

(9.26)
$$Q_* = \frac{Q_{tot}}{\rho_a c_p T_a \sqrt{gD} D^2}$$

where Q_{tot} is the heat release rate of the fire in W (see below), ρ_a, c_p and T_a are the density (kg/m^3), specific heat capacity (J/kg/K) and temperature (K), respectively, of ambient air, and g is the acceleration due to gravity.

The expression in equation (9.25) is valid for $0.12 < Q_* < 1.2\text{x}10^4$. Outside of this range, different dependences on Q_* apply (see Drysdale, 1999). In particular, for fully-developed turbulent jet flames, the length is independent of exit velocity, and a useful approximation to flame length (DiNenno *et al*., 1988, Section 2, Chapter 4) is

(9.27) $$\frac{H}{d} = \frac{15}{C_T}\sqrt{\frac{M_a}{M_f}}$$

where d is the exit diameter, M_a and M_f are the molecular weights of air and fuel respectively, and C_T is the fuel concentration in a stoichiometric fuel-air mixture (e.g. $C_T \approx 0.1$ for methane).

In both the above expressions for flame length, the effects of wind are not taken into account – this aspect is less well understood, and users should refer to the references for more information.

9.9.2 Heat release F_b

This parameter is of particular importance for low momentum fires since it also governs the development of the momentum flux above the fire. However, in a general situation, the heat flux entering the hot plume (F_b) may be expressed as

(9.28) $$F_b = 10^{-6}(1-\alpha_r)Q_{tot}$$

with $Q_{tot} = \varepsilon_c \dot{m}_f H_c$.

In these formulae,

- α_r is the *fraction of heat release radiated*.

  The fraction of heat radiated varies considerably from one fire to another. It depends on the radiative characteristics of the flame, e.g. its temperature and soot content, which in turn depend on the combustion processes taking place, as well as its geometry. A value of α_r = 0.3 is sometimes taken.

- ε_c is the *combustion efficiency*.

  This is likely to depend on the fuel, but is also influenced by the availability of air (e.g. restricted air supply). DiNenno *et al*. (1988, Section 1, Chapter 6) quotes a value of near unity for pools of methanol and heptane, but values of 0.45 and 0.63 for a polystyrene fire and a stack of wood pallets, respectively. The production of significant quantities of smoke by a fire indicates that inefficient combustion is taking place.

- $\dot{m}_f$ is the *fuel supply rate* in kg/s.

  This parameter will be straightforward to estimate in some circumstances, for example in the case of gaseous fuel issuing from a pipe supplied at a known rate. However, in situations where the fuel is liquid or solid, and therefore needs to be converted to the gas phase, the rate at which fuel is supplied itself depends on the intensity of the fire, whose radiant heat acts to vaporise the volatile combustible material in the fuel and so sustain the combustion. There are many data available on the topic of burning rate for different materials and configurations (e.g. DiNenno *et al*. (1988), Section 2, Chapter 1), and the user is advised to refer to these in a given situation.

- H_c is the *heat of combustion* in J/kg.

  This is a standard physical property of the fuel, although it may be less straightforward to estimate if the fuel is a mixture of substances, several of which contribute significantly to the combustion.

9.9.3 Momentum flux F_m

F_m must be the momentum flux at the top of the flame. In many cases it will be possible to make a good estimate of volume flow rate or velocity, and the user will simply use the value found for F_b from the section above, with the definition of F_m in equation (9.23), to calculate the density of the plume to enter into ADMS-Screen.

If no information on velocity or volume flow rate is available, it is possible to estimate the momentum flux at the base of the plume by means of standard plume and jet theory – see, for example, DiNenno *et al*. (1988, Section 1, Chapter 6), Fischer *et al*. (1979, Chapter 9) or Fannelöp (1994).

APPENDIX A Model Limits

A.1 Sources and pollutants

The type of source available and associated emissions are described in Section 3.2. Overall restrictions are as follows.

- Exactly one point source can be modelled in ADMS-Screen.
- The maximum number of pollutants that can be entered into the pollutant palette is 100. The maximum number of pollutants that may be emitted by the source is 80. The maximum number of pollutants that may be output from the model is 10.

APPENDIX B NOx in ADMS-Screen

In ADMS-Screen, all NO_X data (emissions, background concentrations and output concentrations) in mass units are 'NO_X as NO_2'. This Appendix explains what this means and describes the implications for model users.

B.1 What is NOx?

NO_X is the name given to a mixture of two pollutants, nitrogen dioxide (NO_2) and nitrogen oxide (NO). Care must be exercised in specifying NO_X concentrations or emission rates in mass units (e.g. ng/m^3, μg/m^3, mg/m^3, g/s), since a specified volumetric concentration (e.g. in ppb) has a range of mass concentrations, depending on the relative proportions of NO and NO_2.

The conversion factor from ppb to μg/m^3 for any gaseous pollutant is M/24.06 (derived from the Ideal Gas Equation with an ambient temperature of 20°C and pressure of 1013 mb), where M is the molecular mass of the pollutant in grams. For example, the molecular mass of NO_2 is 46 g, so the conversion factor for NO_2 is 1.91. Similarly, the molecular mass of NO is 30 g, so the conversion factor for NO is 1.25. Therefore, for instance, 10 ppb NO_X could be 19.1 μg/m^3 if it is all NO_2, or 12.5 μg/m^3 if it is all NO, or somewhere in between for a mixture of NO and NO_2.

The following sections discuss how NO_X is treated in ADMS-Screen. This is especially important, as it is standard practice to express concentrations of NO_X in mass units as 'NO_X as NO_2'.

B.2 What does 'NOx as NO2' mean?

Pollutant levels can be measured in terms of volumetric concentration, and converted to a mass concentration using the Ideal Gas Equation, which is dependent on the molecular mass of the pollutant. Since NO_X is a composite pollutant, its effective molecular mass depends on the relative proportions of its constituents. This is often not known, so the assumption often made in the conversion is that NO_X has the molecular mass of NO_2; the resulting mass concentration is termed a '**NO_X as NO_2**' concentration.

More generally, the term 'NO_X as NO_2' refers to any mass emission rate or mass concentration of NO_X that has been calculated from a volumetric emission rate or concentration assuming that 100% of the NO_X is NO_2. Note that 'NO_X as NO_2' mass concentrations (and emission rates) generally overestimate the true situation, since the molecular mass of NO_2 (46 g/mol) is greater than the molecular mass of NO (30 g/mol).

When actual masses of each of NO and NO_2 are used to convert from volumetric to mass units, the NO_X concentration is referred to as '**True NO_X**' in this *User Guide*.

B.3 Treatment of NOx in ADMS-Screen

In ADMS-Screen, all NO_X data in mass units are 'NO_X as NO_2'.

- NO_X emission rates must be input as 'NO_X as NO_2' values. If you have 'true NO_X' emission rate data, these must be converted to 'NO_X as NO_2' before being input to ADMS-Screen. Instructions for this conversion are given in Section B.4.
- Background concentrations of NO_X entered into the model in mass units must be 'NO_X as NO_2'. If background data have been obtained in the form of 'True NO_X', these must be converted to 'NO_X as NO_2', before being entered into the model.
- NO_X concentrations output from ADMS-Screen in mass units are also 'NO_X as NO_2'. When comparing ADMS-Screen results with, for example, measured concentrations, care should be taken that both sets of data are in the same form. ADMS-Screen output concentrations can be converted to 'True NO_X', if required, using the methods described in Section B.4 below.

B.4 Converting between 'NOx as NO2' and 'True NOx'

This section describes how NO_X emission rates or concentrations in mass units can be converted from 'True NO_X' to 'NO_X as NO_2', and vice versa. In each case, it is just necessary to convert the NO part of the NO_X concentration. Therefore,

To convert from 'True NO_X' to 'NO_X as NO_2':

$$\text{'}NO_X \text{ as } NO_2\text{'} = NO_2 + \frac{M_{NO_2}}{M_{NO}} (\text{'True } NO_X\text{'} - NO_2) \quad (2)$$

where M_{NO_2} is the molecular mass of NO_2 (46 g/mol) and M_{NO} is the molecular mass of NO (30 g/mol). For example, an emission rate of 10 g/s 'True NO_X', of which 2 g/s is NO_2, is equivalent to 14.3 g/s 'NO_X as NO_2'.

And to convert from 'NO_X as NO_2' to 'True NO_X':

$$\text{'True } NO_X\text{'} = NO_2 + \frac{M_{NO}}{M_{NO_2}} (\text{'}NO_X \text{ as } NO_2\text{'} - NO_2) \quad (3)$$

For example, a concentration of 10 $\mu g/m^3$ 'NO_X as NO_2', of which 5 $\mu g/m^3$ is NO_2, is equivalent to 8.26 $\mu g/m^3$ 'True NO_X'.

Note that if you are converting an emission rate, and the emission rate of NO_2 is unknown, it will be necessary to make an assumption regarding the fraction of the NO_X emission rate that is NO_2.

APPENDIX C Air Quality Limits and Guidelines

This section summarises air quality limits, guidelines and objectives. The limits are subject to change; it is therefore important to ensure that you are referring to current limits.

The air quality limits, guidelines and objectives for the main pollutants are listed below as follows.

- Section C.1: UK Air Quality Strategy and Regulations.
- Section C.2: EU limit values.
- Section C.3: Lithuanian limit values
- Section C.4: French Limit Values
- Section C.5: US National Ambient Air Quality Standards.
- Section C.6: World Health Organisation guidelines.

Relationship between percentiles and exceedences

Many of the air quality limits are stated in terms of *"not more than N exceedences of a threshold value per year"*, where *N* is an integer. The limits can be restated in terms of percentiles by calculating the appropriate percentile from the maximum number of exceedences *N*, as described below. In ADMS 6, results can be calculated in terms of exceedences (in which case the threshold values are specified by the user on the **Output** screen) and/or percentiles (in which case the percentiles to be calculated are specified on the **Output** screen).

For example, the UK AQS particulates (PM_{10}) limit is *"not more than 35 exceedences per year of 50 mg/m³ as a 24-hour average"*. This means that 35 exceedences are acceptable, whereas 36 are not. The corresponding percentile to be calculated is therefore

$$\frac{365-35}{365}\times 100 = 90.41^{th} \text{ percentile}$$

where 365 is the number of 24 hour periods per year. If the limit is stated in terms of the hourly average, the percentile is calculated using

$$\frac{8760-N}{8760}\times 100$$

where 8760 is the number of 1-hour periods per year. Similarly for a 15-minute average, the number of 15-minute intervals per year is 35040, so the percentile to be calculated is

$$\frac{35040-N}{35040}\times 100.$$

C.1 UK Air Quality Strategy and Regulations

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland[1] (AQS), published in 2007 by the Department for Environment, Food and Rural Affairs (Defra), defines a reviewed set of limits and targets on pollutant concentrations. Some of them already have a legal status[2,3,4,5,6].

Table C.1 lists UK air quality objectives for England, Wales, Scotland and Northern Ireland. The Environmental Protection UK website[7] is a useful source of information as well as the UK legislation website[8] for the air quality regulations.

Pollutant	Region	Measured as	Limit, objective or target	Concentration[9]	Maximum no. of exceedences allowed	Exceedence expressed as percentile[10]
Benzene	UK	Running annual mean	Objective[1]	16.25 $\mu g/m^3$ (5 ppb)	-	n/a
	UK	Annual mean	Limit[2-5]	5 $\mu g/m^3$ (1.54 ppb)	-	n/a
	Scotland and Northern Ireland	Running annual mean	Objective[1]	3.25 $\mu g/m^3$ (1 ppb)	-	n/a
1,3-Butadiene	UK	Running annual mean	Objective[1]	2.25 $\mu g/m^3$ (1 ppb)	-	n/a
Carbon monoxide (CO)	UK	Maximum daily running 8-hour mean	Limit[2-5]	10 mg/m^3 (8.6 ppm)	None	100th percentile
	Scotland	Running 8-hour mean	Objective[1]	10 mg/m^3 (8.6 ppm)	None	100th percentile
Lead (Pb)	UK	Annual mean	Limit[2-5]	0.5 $\mu g/m^3$	-	n/a
	UK	Annual mean	Objective[1]	0.25 $\mu g/m^3$	-	n/a
Nitrogen dioxide (NO_2)	UK	1-hour mean	Limit[2-5]	200 $\mu g/m^3$ (105 ppb)	18 times a year	99.79th percentile
	UK	Annual mean	Limit[2-5]	40 $\mu g/m^3$ (21 ppb)	-	n/a
Nitrogen oxides (NO_X)	UK	Annual mean	Critical level[2-5]	30 $\mu g/m^3$ (16 ppb) [11]	-	n/a

Table C.1 – UK air quality regulations.

Pollutant	Region	Measured as	Limit, objective or target	Concentration[9]	Maximum no. of exceedences allowed	Exceedence expressed as percentile[10]
Ozone (O_3)	UK	Maximum daily running 8-hour mean	Target[2-5]	120 μg/m^3	25 days per year (averaged over 3 years)	-
	UK	Maximum daily running 8-hour mean	Long-term objective[2-5]	120 μg/m^3	-	-
	UK	Maximum daily running 8-hour mean	Objective[1]	100 μg/m^3	10 times a year	97.26th percentile
	UK	AOT40 calculated from 1 hour values from May to July, average over 5 years	Target[2-5]	18,000μg/m^3 × h [11]	-	n/a
	UK	AOT40 calculated from 1 hour values from May to July	Long-term objective[2-5]	6,000μg/m^3 × h [11]	-	n/a
Particulate matter (PM_{10})	UK	24-hour mean	Limit[2-5]	50 μg/m^3	35 times a year	90.41th percentile
	UK	Annual mean	Limit[2-5]	40 μg/m^3	-	n/a
	Scotland	24-hour mean	Objective[1]	50 μg/m^3	7 times a year	98.08th percentile
	Scotland	Annual mean	Objective[1]	18 μg/m^3	-	n/a
Particulate matter ($PM_{2.5}$)	UK	Annual mean	Limit[2-5]	20 μg/m^3 [12]	-	n/a
	Scotland	Annual mean	Objective[1]	10 μg/m^3 [6]	-	n/a
Sulphur dioxide (SO_2)	UK	15-minute mean	Objective[1]	266 μg/m^3 (100 ppb)	35 times a year	99.90th percentile
	UK	1-hour mean	Limit[2-5]	350 μg/m^3 (132 ppb)	24 times a year	99.73th percentile
	UK	24-hour mean	Limit[2-5]	125 μg/m^3 (47 ppb)	3 times a year	99.18th percentile
	UK	Annual mean	Critical level[2-5]	20 μg/m^3 (8 ppb) [11]	-	n/a
	UK	Winter mean (1st October – 31st March)	Critical level[2-5]	20 μg/m^3 (8 ppb) [11]	-	n/a

Table C.1 – UK air quality regulations. *(continued)*

Pollutant	Region	Measured as	Limit, objective or target	Concentration[9]	Maximum no. of exceedences allowed	Exceedence expressed as percentile[10]
PAHs (benzo[a]pyrene)	UK	Annual mean	Target[2-5]	1 ng/m^3	-	n/a
	UK	Annual mean	Objective[1]	0.25 ng/m^3	-	n/a
Arsenic	UK	Annual mean	Target[2-5]	6 ng/m^3	-	n/a
Cadmium	UK	Annual mean	Target[2-5]	5 ng/m^3	-	n/a
Nickel	UK	Annual mean	Target[2-5]	20 ng/m^3	-	n/a

Table C.1 – UK air quality regulations. *(continued)*

1. Department for Environment, Food and Rural Affairs, 2007: The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: volume 1. Published in partnership with the Scottish Executive, the National Assembly for Wales and the Department of the Environment for Northern Ireland. Available on uk-air.defra.gov.uk/air-pollution/uk-eu-limits
2. The Air Quality Standards Regulations 2010, UK Statutory Instruments 2010 no. 1001.
3. The Air Quality Standards (Wales) Regulations 2010, Wales Statutory Instruments, 2010 no. 1433 (W.126).
4. The Air Quality Standards (Scotland) Regulations 2010, Scottish Statutory Instruments, 2010 no. 204.
5. The Air Quality Standards Regulations (Northern Ireland) 2010, Northern Ireland Statutory Rules, 2010 no. 188.
6. The Air Quality (Scotland) Amendment Regulations 2016, Scottish Statutory Instruments, 2016 no. 162.
7. www.environmental-protection.org.uk/air-quality-and-climate/air-quality/.
8. www.legislation.gov.uk/
9. Conversions of ppb and ppm to $\mu g/m^3$ and mg/m^3 at 20°C and 1013 mb.
10. Percentile values are given for reference and are not defined explicitly in the air quality standards.
11. Objective for protection of vegetation and ecosystems.
12. 20 $\mu g/m^3$ is a cap to be seen in conjunction with 15% reduction in urban areas.

C.2 EU limit values

The EU limit values[1,2] are listed in **Table C.2**.

Pollutant	Measured as	Limit concentration[3]	Maximum no. of exceedences allowed	Exceedence expressed as percentile[4]
Benzene[1]	Annual mean	5 μg/m^3	-	n/a
Carbon monoxide[1] (CO)	Maximum daily running 8-hour mean	10 mg/m^3	None	100th percentile
Lead[1] (Pb)	Annual mean	0.5 μg/m^3	-	n/a
Nitrogen dioxide[1] (NO_2)	1-hour mean	200 μg/m^3 (104 ppb)	18 times a year	99.79th percentile
	Annual mean	40 μg/m^3 (21 ppb)	-	n/a
Nitrogen oxides[1] (NO_X)	Annual mean	30 μg/m^3	-	n/a
Ozone[1] (O_3)	Maximum daily running 8-hour mean	120 μg/m^3	25 days per year (averaged over 3 years)	-
	AOT40[5], calculated from 1-h values from May to July and averaged over 5 years	18000 μg/m^3 × h	-	n/a
	Maximum daily running 8-hour mean within one year	120 μg/m^3	None	100th percentile
	AOT40[5], calculated from 1-h values from May to July	6000 μg/m^3 × h	-	n/a
Particulate matter[1] (PM_{10})	24-hour mean	50 μg/m^3	35 times a year	90.41th percentile
	Annual mean	40 μg/m^3	-	n/a
Particulate matter[1] ($PM_{2.5}$)	Annual mean	25 μg/m^3	-	n/a

Table C.2 – EU limit values.

Pollutant	Measured as	Limit concentration[3]	Maximum no. of exceedences allowed	Exceedence expressed as percentile[4]
Sulphur dioxide[1] (SO_2)	1-hour mean	350 $\mu g/m^3$ (130 ppb)	24 times a year	99.73^{th} percentile
	24-hour mean	125 $\mu g/m^3$ (46 ppb)	3 times a year	99.18^{th} percentile
	Annual mean (calendar) and winter mean (1 October to 31 March)	20 $\mu g/m^3$ (7.4 ppb)	-	n/a
Arsenic[2]	Annual mean	6 ng/m^3	-	n/a
Cadmium[2]	Annual mean	5 ng/m^3	-	n/a
Nickel[2]	Annual mean	20 ng/m^3	-	n/a
PAHs (benzo[a]pyrene) [2]	Annual mean	1 ng/m^3	-	n/a

Table C.2 – EU limit values. *(continued)*

1. Directive 2008/50/EC of the European Parliament and Council of 21 May 2008 on ambient air quality and cleaner air for Europe.
2. Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.
3. Conversions of ppb and ppm to $\mu g/m^3$ and mg/m^3 at 20°C and 1013 mb.
4. Percentile values are given for reference and are not defined explicitly in the air quality standards.
5. AOT40 (see corresponding directive) means the sum of the difference between hourly concentrations greater than 40 ppb (80 $\mu g/m^3$) and 80 $\mu g/m^3$ over a given period (e.g. growing season) using only the hourly values measured between 8:00 and 20:00 Central European Time each day. It is expressed in $\mu g/m^3 \times$ hours.

C.3 Lithuanian limit values

The Lithuanian limits are identical to the EU limits (see Section C.2).

Below is a link to secondary Lithuanian national air quality standards for less-common regulated pollutants:

https://failai.gamta.lt/files/Nacionalines_oro_uzterstumo_normos.pdf

C.4 French Limit Values

The limit values for France[1] are listed in **Table C.3**.

Pollutant	Measured as	Limit concentration	Maximum no. of exceedences allowed	Exceedence expressed as percentile[2]
Benzene[3]	Annual mean	5 μg/m^3	-	n/a
Carbon monoxide (CO)[3]	Maximum daily running 8-hour mean	10 mg/m^3	None	100^{th} percentile
Lead (Pb)	Annual mean	0.5 μg/m^3	-	n/a
Nitrogen dioxide (NO_2)[3, 4]	1-hour mean	200 μg/m^3 (104 ppb)	18 times a year	99.79^{th} percentile
	Annual mean	40 μg/m^3 (21 ppb)	-	n/a
Nitrogen oxides	Annual mean	30 μg/m^3 (16 ppb)	-	n/a
Ozone (O_3)[3, 5]	Maximum daily running 8-hour mean	120 μg/m^3	25 days per year (averaged over 3 years)	-
	AOT40[6], calculated from 1-h values from May to July and averaged over 5 years	18000 μg/m^3 × h	-	n/a
	Maximum daily running 8-hour mean within one year	120 μg/m^3	None	100^{th} percentile
	AOT40[6], calculated from 1-h values from May to July	6000 μg/m^3 × h	-	n/a
Particulate matter (PM_{10})	24-hour mean	50 μg/m^3	35 times a year	90.41^{th} percentile
	Annual mean	40 μg/m^3	-	n/a

Table C.3 – French limit values.

Pollutant	Measured as	Limit concentration	Maximum no. of exceedences allowed	Exceedence expressed as percentile[2]
Particulate matter ($PM_{2.5}$)	Annual mean	25 µg/m^3	-	n/a
Sulphur dioxide (SO_2)[3, 7, 8]	1-hour mean	350 µg/m^3 (130 ppb)	24 times a year	99.73th percentile
	24-hour mean	125 µg/m^3 (46 ppb)	3 times a year	99.18th percentile
	Annual mean (calendar) and winter mean (1 October to 31 March)	20 µg/m^3 (7.4 ppb)	-	n/a
Arsenic	Annual mean	6 ng/m^3	-	n/a
Cadmium	Annual mean	5 ng/m^3	-	n/a
Nickel	Annual mean	20 ng/m^3	-	n/a
PAHs (benzo[a]pyrene)	Annual mean	1 ng/m^3	-	n/a

Table C.3 – French limit values. (*continued*)

1. Code de l'environnement Article R221-1, Modifié par Décret n°2010-1250 du 21 octobre 2010 - art. 1 accessible via www.legifrance.gouv.fr/.
2. Percentile values are given for reference and are not defined explicitly in the air quality standards.
3. The volume must be reduced to conditions of temperature and pressure: 293 K and 101.3 kPa.
4. Alert concentration limit set to 200 or 400 µg/m^3 hourly mean (see corresponding directive).
5. Alert concentration threshold for progressive implementation of emergency measures:

   First level: 240 µg/m^3 average hourly exceeded for three consecutive hours;
   Second level: 300 µg/m^3 average hourly exceeded for three consecutive hours;

Third level: 360 μg/m^3 averaged hourly.

6. AOT40 (see corresponding directive) means the sum of the difference between hourly concentrations greater than 40 ppb (80 μg/m^3) and 80 μg/m^3 over a given period (e.g. growing season) using only the hourly values measured between 8:00 and 20:00 Central European Time each day. It is expressed in μg/m^3 × hours.
7. Objective of 50 μg/m^3 annual average.
8. Alert concentration limit set to 500 μg/m^3 hourly average exceeded for three consecutive hours (see corresponding directive).

C.5 US National Ambient Air Quality Standards

Table C.4 lists the US National Ambient Air Quality Standards (NAAQS) as given by the U.S. Environmental Protection Agency[1].

Pollutant	Primary or Secondary[2]	Measured as	Limit concentration[3]	Maximum no. of exceedences allowed	Exceedence expressed as percentile[4]
Carbon monoxide (CO)	Primary	1-hour mean	35ppm (40 mg/m^3)	Once a year	99.99th percentile
	Primary	Running 8-hour mean	9 ppm (10 mg/m^3)	Once a year	99.99th percentile
Lead (Pb)	Both	Running 3-month mean	0.15 μg/m^3	-	n/a
Nitrogen dioxide (NO_2)	Both	Annual mean	53 ppb (28 μg/m^3)	-	n/a
	Primary	3-year average of the 98th percentile of the daily maximum 1-hour mean	100 ppb (52 μg/m^3)	-	n/a
Ozone	Both	3-year average of the fourth-highest daily maximum running 8-hour mean over each year	0.070 ppm (137 μg/m^3)	-	n/a
Particulate matter (PM_{10})	Both	24-hour mean	150 μg/m^3	Once a year (on average over 3 years)	-
Particulate matter ($PM_{2.5}$)	Both	3-year average of the 98th percentile of the 24-hour mean	35 μg/m^3	-	n/a
	Secondary	3-year average of the annual mean	15.0 μg/m^3	-	n/a
	Primary	3-year average of the annual mean	12.0 μg/m^3	-	n/a
Sulphur dioxide (SO_2)	Secondary	3-hour mean	0.5 ppm (1300 μg/m^3)	Once a year	99.97th percentile
	Primary	3-year average of the 99th percentile of the daily maximum 1-hour mean	75 ppb (195 μg/m^3)	-	n/a

Table C.4 – US National Ambient Air Quality Standards.

1. National Ambient Air Quality Standards (40 CFR part 50), U.S. Environmental Protection Agency, 2010. Available on www.epa.gov/criteria-air-pollutants/naaqs-table (see website for more detail).
2. Primary standards are defined for the protection of public health, whereas secondary standards are defined for the protection of public welfare, for example to minimise effects on visibility and vegetation.
3. mg/m^3 and $\mu g/m^3$ concentrations are approximately equivalent values.
4. Percentile values are given for reference and are not defined explicitly in the air quality standards.

C.6 World Health Organisation guidelines

The World Health Organisation (WHO) guidelines[1,2] are listed in **Table C.5**.

Pollutant	Measured as	Interim target				AQG level	Units	Maximum no. of exceedences allowed	Exceedence expressed as percentile
		1	2	3	4				
Carbon monoxide[1] (CO)	15-minute mean	-	-	-	-	100	mg/m^3	None	100th percentile
	1-hour mean	-	-	-	-	35	mg/m^3	None	100th percentile
	Running 8-hour mean	-	-	-	-	10	mg/m^3	None	100th percentile
	24-hour mean	7	-	-	-	4	mg/m^3	3 times a year	99th percentile
Lead[1] (Pb)	Annual mean	-	-	-	-	0.5	µg/m^3	-	n/a
Nitrogen dioxide[2] (NO_2)	1-hour mean	-	-	-	-	200	µg/m^3	None	100th percentile
	24-hour mean	120	50	-	-	25	µg/m^3	3 times a year	99th percentile
	Annual mean	40	30	20	-	10	µg/m^3	-	n/a
Particulate matter[2] (PM_{10})	24-hour mean	150	100	75	50	45	µg/m^3	3 times a year	99th percentile
	Annual mean	70	50	30	20	15	µg/m^3	-	n/a
Particulate matter[2] ($PM_{2.5}$)	24-hour mean	75	50	37.5	25	15	µg/m^3	3 times a year	99th percentile
	Annual mean	35	25	15	10	5	µg/m^3	-	n/a
Ozone[2] (O_3)	Daily maximum running 8-hour mean	160	120	-	-	100	µg/m^3	3 times a year	99th percentile
	Peak season[3]	100	70	-	-	60	µg/m^3	None	100th percentile
Sulphur dioxide[2] (SO_2)	10-minute mean	-	-	-	-	500	µg/m^3	None	100th percentile
	24-hour mean	125	50	-	-	40	µg/m^3	3 times a year	99th percentile
Cadmium[1] (Cd)	Annual mean	-	-	-	-	5	ng/m^3	-	n/a

Table C.5 – World Health Organisation guidelines.

1. WHO Regional Office for Europe, 2000: Air Quality Guidelines for Europe, Second Edition. WHO Regional Publications, European Series, No. 91. Available from www.euro.who.int/.

2. WHO Regional Office for Europe, 2022: Air Quality Guidelines, Global Update 2021 − Particulate Matter, Ozone, Nitrogen Dioxide, Sulfur Dioxide and carbon monoxide. Available from www.euro.who.int/.

3. Average of daily maximum 8-hour mean O_3 concentration in the six consecutive months with the highest six-month running-average O_3 concentration.

APPENDIX D Surfer Tips

This appendix is intended only as a quick guide to some of the more frequently used features of Surfer, namely:

- how to create contour maps (2D),
- how to create surface maps (3D),
- how to overlay contours on digital map tiles or surface maps,
- how to customise a map,

This is not a comprehensive guide to all the features of the Surfer software package and it is recommended that users refer to the online help or to the Surfer user manual for further information. The information given in this section is based on Surfer 24; other versions of Surfer may differ.

D.1 Contour maps (2-dimensional)

Contour maps are useful to visualise gridded data such as concentrations, etc.

Contour maps of concentrations should be produced using the **2-D Output Plotter (Plotting in Surfer)** utility (refer to Section 6.2 for details). Contour maps of other quantities can be produced as explained below, as long as the data format is XYZ ASCII, i.e. X, Y and Z coordinates in a text file.

There are two steps to creating a contour map:

1. create a grid (*.grd*) file from the original data,
2. make a contour map from the grid file.

Any contour map in Surfer is based on a grid file (.grd) that contains the data to be plotted, interpolated onto a regular grid.

Open Surfer and select **New Plot**, or select the **File**, **New**, **Plot document** menu option if Surfer is already open. This example shows how to create a contour map of terrain data.

Step 1 Click the **Grid Data** icon in the **Home** (or **Grids**) tab and **Browse…** to open the terrain file.

You will need to choose **Files of type: All Files (*.*)** to be able to see all files and select the terrain file you want to use.

Step 2 On the **Data Import Options** screen, shown in **Figure D.1**, verify that the data will be read in as comma-delimited format and click on **OK**.

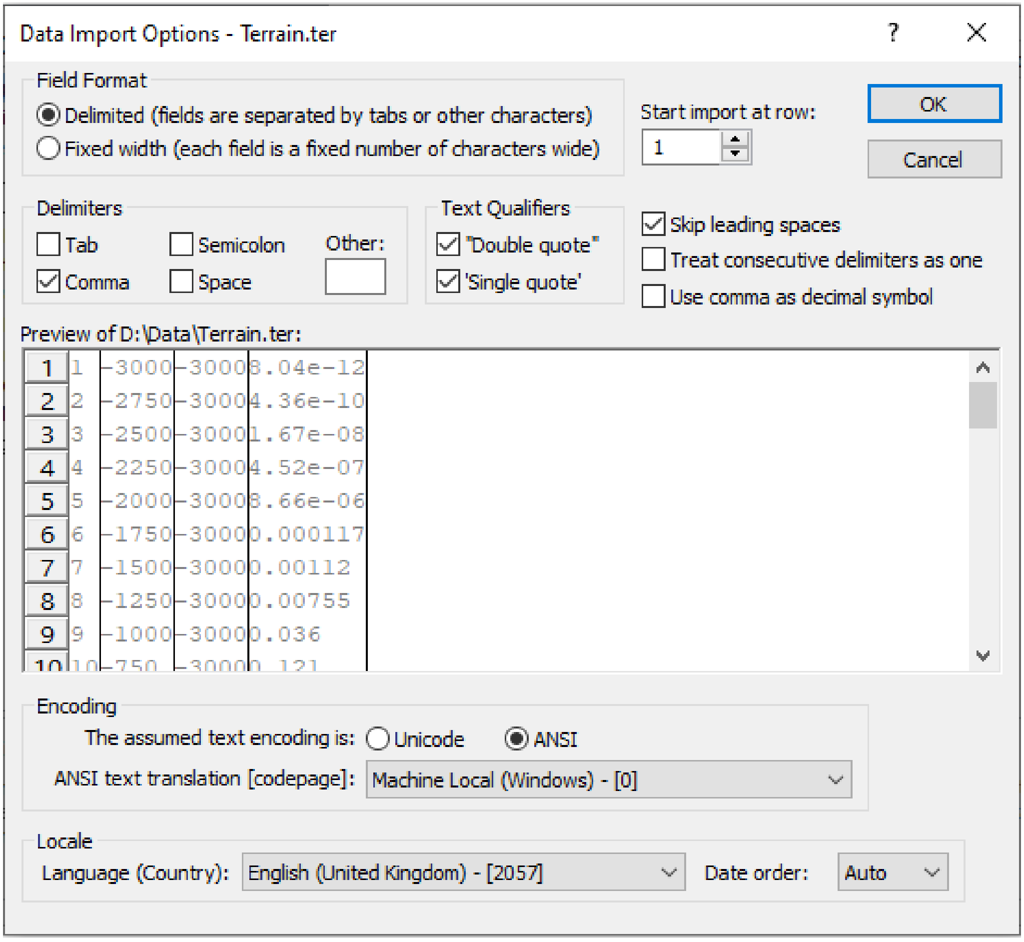


Figure D.1 – Data import options for the terrain file.

Step 3 On the **Grid Data** screen, shown in **Figure D.2**, select columns B, C and D corresponding to X, Y and Z respectively. The first column in the terrain file, column A, contains a counter that is not needed in the plotting.

In this screen you can change the gridding method.

Click on **Next>** to step through options relating to that gridding method in detail, or **Skip to End >>** to enter the resolution and output location, **Figure D.3**.

Click **Finish** to create the *.grd* file.

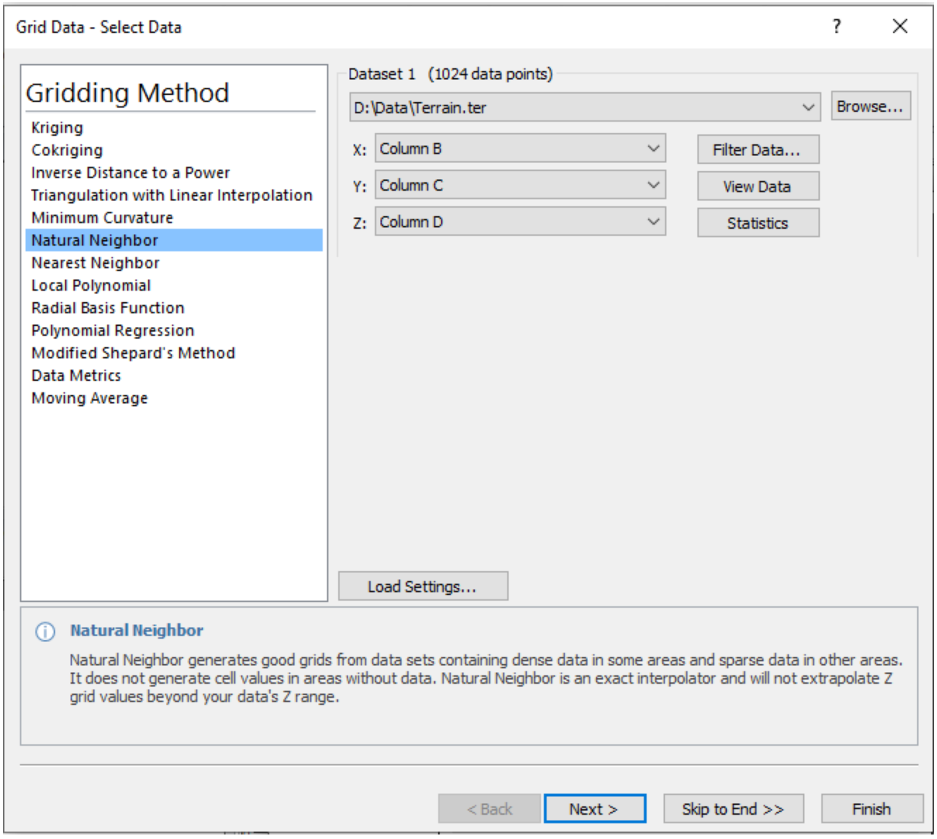


Figure D.2 – Select data settings for gridding the terrain file.

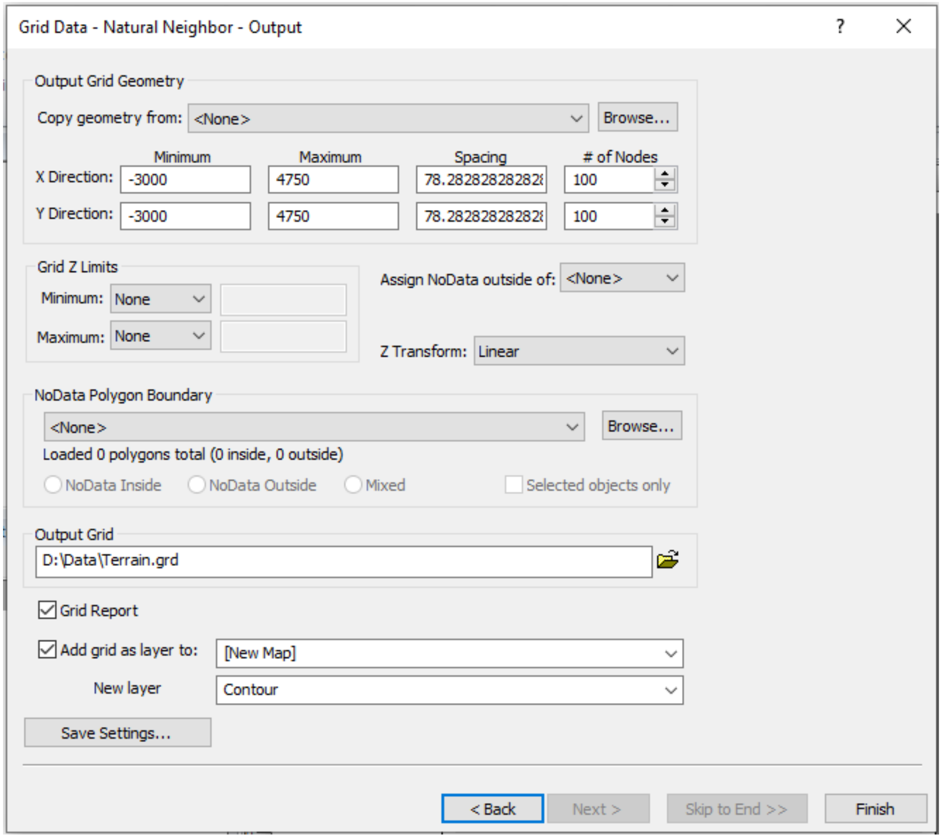


Figure D.3 – Output settings for gridding the terrain file.

Step 4 This should create a contour plot of the *.grd* file in the plot document, if not click the **Contour** icon, in the **New Map** section of the **Home** tab and then select the grid file just created.

The contour map is created with a default layout. Section D.4 describes how to customise the colours, labels and other features of a map.

An example of a final contour map is shown in **Figure D.4**.

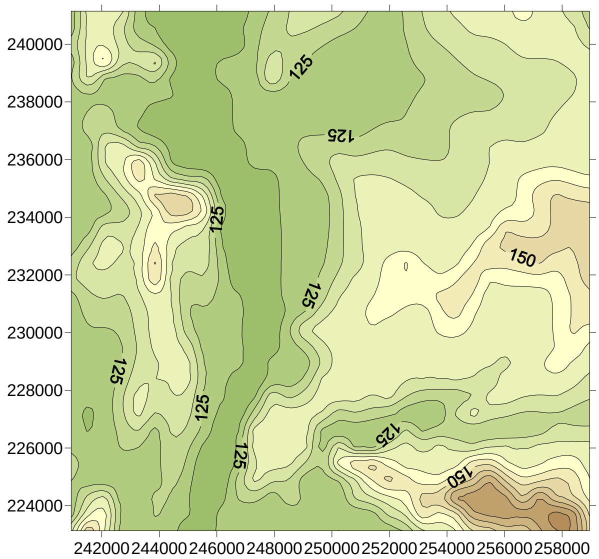


Figure D.4 – Example of a contour map of terrain data.

D.2 Surface maps (3-dimensional)

Creating a 3D plot is an alternative way of visualising the terrain data.

Open Surfer and select **New Plot**, or select the **File**, **New**, **Plot document** menu option if Surfer is already open.

As with the creation of contour maps, you first need to create a grid file (*.grd*) from your data. Create a *.grd* file as described in Section D.1. Click the **3D Surface** icon in the **Home** tab to create a 3-D surface map.

The remainder of this section describes how to create a contour map with contour lines (isopleths) from which a 3D map with isopleths is made.

Any surface map in Surfer is based on a grid file (.grd*) which contains the data to be plotted interpolated onto a regular grid.*

D.2.1 Create the grid file

In order to create both 2D and 3D maps, you will need a grid file of the data to be plotted. Refer to Section D.1 for instructions on how to create a grid file.

D.2.2 Create the 2D contour map

Once the grid file has been created, produce the contour map of the terrain data, as explained in Section D.1. Customise the map (see Section D.4).

The appearance of the final 3D surface map, in terms of contour levels, colours, etc. must first be set up at this stage in the 2D contour map.

For this example the final contour map of the terrain file is the same as that shown in **Figure D.4**.

D.2.3 Create the 3D surface map

Once the 2D contour map has been created and customised, open a new Surfer plot document (**File**, **New**, **Plot document**) and create the 3D surface map, from the same data, as follows.

Step 1 Open the terrain grid file after clicking the **3D Surface** icon.

A default 3D view of the terrain file is produced by Surfer as illustrated in **Figure D.5**.

This step could be achieved in the same Surfer plot as that of the 2D contour map. In such case, go directly to Step 3.

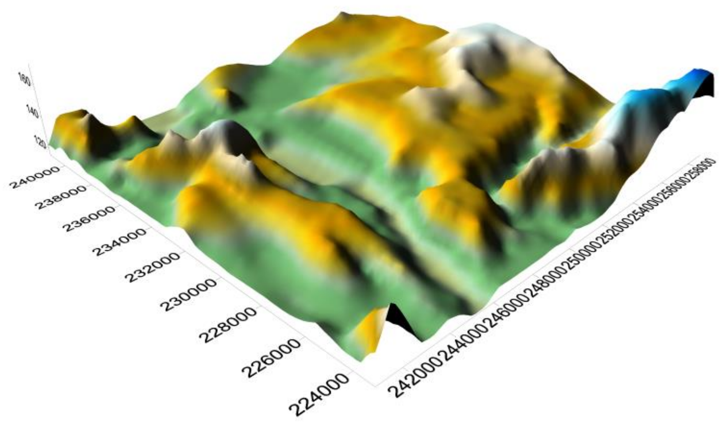


Figure D.5 – Default 3D view of the terrain file.

Step 2 To overlay the contour plot on the surface plot, go back to the contour plot, copy it (click the **Select All** and then **Copy** icons in the **Home** tab) and paste it onto the surface plot document (**Paste** icon in the **Home** tab).

Step 3 To set both plots on the same spatial scales, select and overlay them (**Select All** icon, followed by the **Overlay Maps** icon in the **Map Tools** tab).

Step 4 In order to use the colours of the contour plot only, click on **3D surface** in the **Contents** window. Then click on the **Overlays** tab in the **Properties** window. Click on the cell next to **Color modulation** and from the drop down menu select **Use Overlay color only**.

An example of a final 3D map of a terrain file is shown in **Figure D.6**.

Many elements of the plot can be modified. Please refer to Section D.4 for details of how to do this.

It is often useful to change the perspective of the map, add more details (level intervals), look at the coordinates to check that the required area is covered, etc. Click on **3D Surface** in the **Contents** window to access the **Properties** window for the 3D surface properties.

The colours of the surface map can be modified in the **General** tab by clicking on the colour ramp. X and Y grid lines can be overlaid (**Mesh** tab). Light and shadow effects are available in the **Lighting** tab. The **Overlays** tab controls how plots are to be overlaid. The 3D parameters of the plot can be changed by clicking on **Map** in the **Contents** window and then clicking on the **View** tab in the **Properties** window. The spatial scale and map extents are gathered in the **Scale** and **Limits** tabs.

Figure D.6 – Contour plot overlaid on the surface plot.

D.3 Overlay on a digital or surface map

Displaying standard contour maps of concentration on top of digital base maps or 3D surface maps allows attractive layouts for reports to be created without the need to purchase a Geographical Information System (GIS). **Figure D.7** shows examples of a digital map with either overlaid contour lines or colour-filled transparent contours. **Figure D.8** gives an example of site characteristics, such as the locations of the stack and/or receptors, overlaid on a surface map.

The next section explains how to overlay an ADMS-Screen item (contour map of concentrations or site characteristics) on such maps. The same methodology can be used to overlay both types of data.

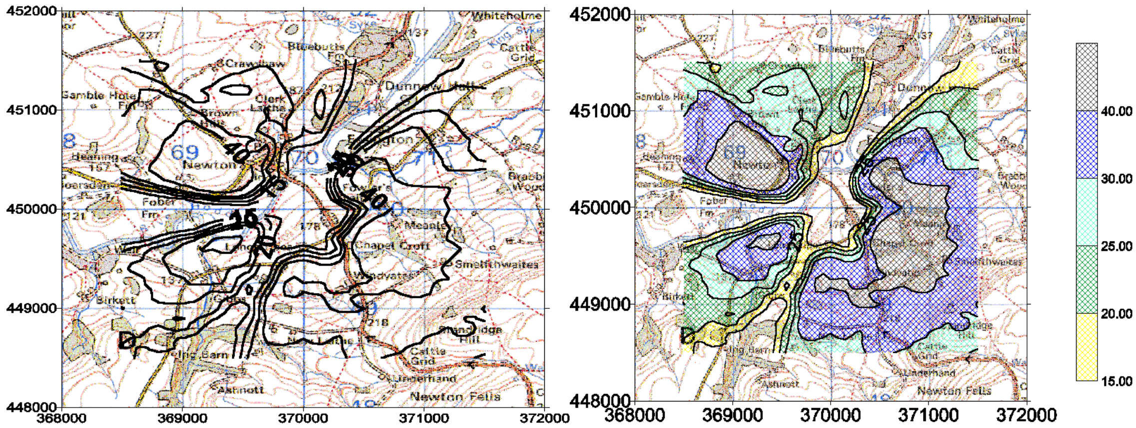


Figure D.7 – Digital map with contour lines overlaid (left) or colour-filled contours overlaid (right) produced with Surfer.

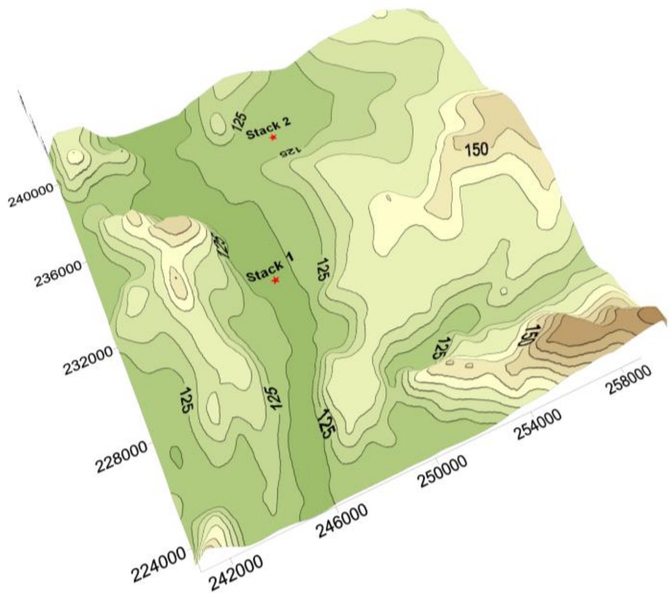


Figure D.8 – Surface map with overlaid site characteristics produced with Surfer.

To overlay an ADMS-Screen item on a map there are three steps:

1. prepare the map (digital base map or terrain surface map),
2. prepare the item to overlay (contour map of concentration, stack location, etc.),
3. merge both together to produce the final map.

The map and the item(s) to overlay should use the same coordinate system to ensure that the overlaid item is located at the correct geographical reference point on the map.

D.3.1 Prepare the map

The map can be any image, as long as it has appropriate geospatial information (e.g. uses a world file). Typically the base map will be a digital map (of the region of interest) or a surface map (showing the topography of the region).

Digital base map

Digital map data are available in a large number of graphical formats such as *.tif*, *.dxf*, etc. The tile position can be geographically referenced. For more information about appropriate formats of digital map data, please consult the Surfer user guide.

Step 1 Click the **Base** icon in the **Home** tab and locate the base map you want to use.

The map is loaded into Surfer as illustrated in **Figure D.9**. In this example, it covers approximately a 5 km × 5 km area. Depending on the extent and the resolution of your map, you might need to zoom into a small section to view the data in more detail and check that the tile is for the area you want.

Note that many different formats of base maps can be loaded, including AutoCAD drawings, bitmaps, Windows metafiles, etc.

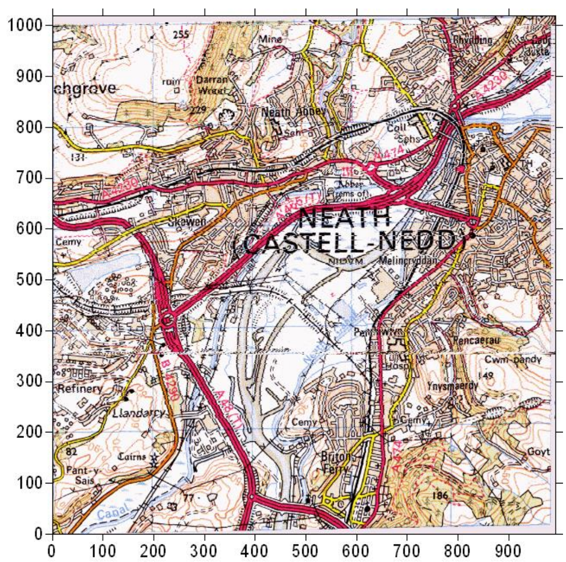


Figure D.9 – Base map loaded into Surfer.

Step 2 If the input base map does not contain geographical information, for instance through a world file, then the X and Y axes are automatically labelled relative to an origin (0,0) at the bottom left-hand corner. As previously explained, it may be necessary to reference the base map geographically to ensure the coordinate system matches that used by ADMS-Screen. To do this, select **Base** in the **Contents** window and click the **Georeference Image...** button in the **General** tab of the **Properties** window. Click the **Add Corner Points** button and change the **Target X** and **Target Y** values in the resulting table to the specify the actual minimum and maximum X and Y coordinates of the map. Close the window, choosing to save the changes and adjust the map limits, to apply the new coordinates to the map as shown in **Figure D.10**.

Step 3 Save this Surfer file.

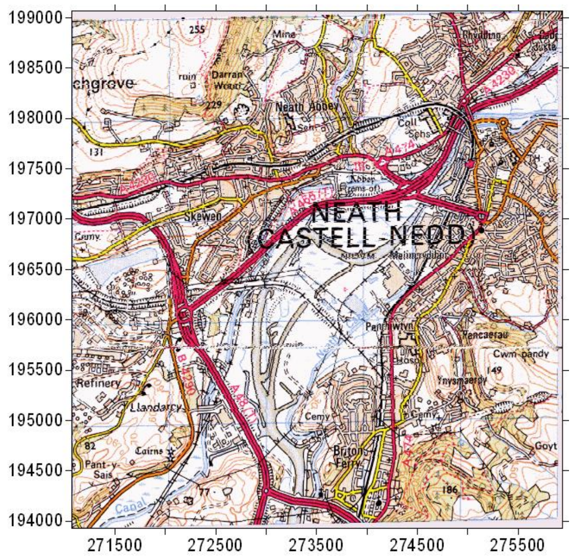


Figure D.10 – Synchronised map coordinates with ADMS-Screen coordinates.

Terrain surface map

A surface map of the terrain file can be created in the usual way (refer to Section D.2). When you are happy with its appearance, save it as a Surfer file.

It is always possible to modify the map appearance after an item has been overlaid on it. Just click on the surface map to access its appearance properties.

D.3.2 Prepare the item to overlay

Many different items can be overlaid on the map. The most commonly used are a contour map of concentrations and the locations of the stack and receptors (if any). There is no restriction on the number of items that can be overlaid.

Each item to be overlaid should be prepared as explained below.

Contour map of concentration

Create the Surfer contour map in the usual way (refer to Section D.1), editing the levels, labels, fonts, etc., as detailed previously. Choose whether you require filled contours or just a series of contour lines, although this could be modified once the contour map has been overlaid on the map. When you are happy with the contour map save it as a Surfer file (*.srf*).

Site characteristics

In this example, we only consider two potential locations of the stack of an industrial site. The stack positions can be imported into Surfer by creating a *Post Map*, as follows.

Step 1 Go to **File, New** and select **Worksheet**, then enter the X and Y coordinates of the stack locations and, optionally, the stack names (see **Figure D.11**).

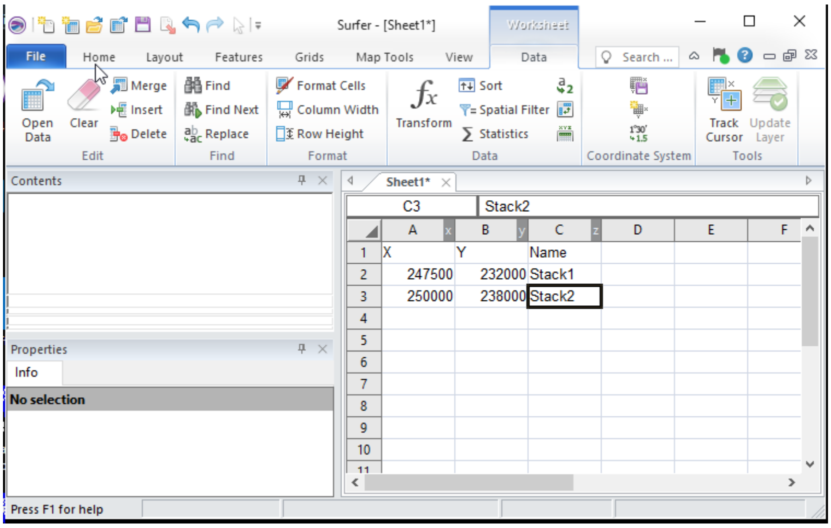


Figure D.11 – Stack locations.

Step 2 Save the file as **Text Data** (*.txt*). A **Data Export Options** dialogue window will appear. You can use this to select the **Delimiter** and the **Text Qualifier** before saving the file. Close the worksheet.

D.3.3 Overlay the item on the map

The items can be overlaid one at a time or with several items together.

Most of the appearance properties of the map and the item can be edited after the item has been overlaid on the map. The only exception to this is the coordinate system, which must be defined prior to the overlay step.

Overlay site characteristics

To overlay the stack locations on a map, proceed as follows.

Step 1 Open the digital base map or the terrain surface map previously saved.

Step 2 Click on the **Post** icon in the **Home** tab and select the text file previously created. This adds the stack locations to the map.

Step 3 To get the two images on the same spatial scale, click **Select All** followed by **Overlay Maps**. The stack locations are overlaid on the map.

Figure D.8 shows an example of the final 3D view of the terrain file with two possible locations of the stack of an industrial site.

You can edit the post map properties by clicking on **Post** in the **Contents** window. Several options are then available in the **Properties** window. The **Symbol** tab allows you to modify the stack symbol. In the **Labels** tab, you can choose to display the name of the stacks (if they are in the post map file) and set the font, colour and size to use to display the labels.

Overlay a contour map of concentration

To overlay the contour map of concentrations on a map, proceed as follows.

Step 1 Open the digital base map or the terrain surface map previously saved.

Step 2 Open the contour map you wish to overlay.

Step 3 Click on the contour map, click **Select All** and then **Copy**. Click on the digital base map, click **Paste**.

Step 4 To get the two images on the same spatial scale, click **Select All** followed by **Overlay Maps**.

---

*If the contour map does not appear, it may lie below the map image. Select **Base** in the **Contents** window and click the **Send to Back** icon in the **Layout** tab to set it as the bottom layer. The contour map will then be located on top of the base map.*

Figure D.12 shows an example of a contour map overlaid on a digital base map.

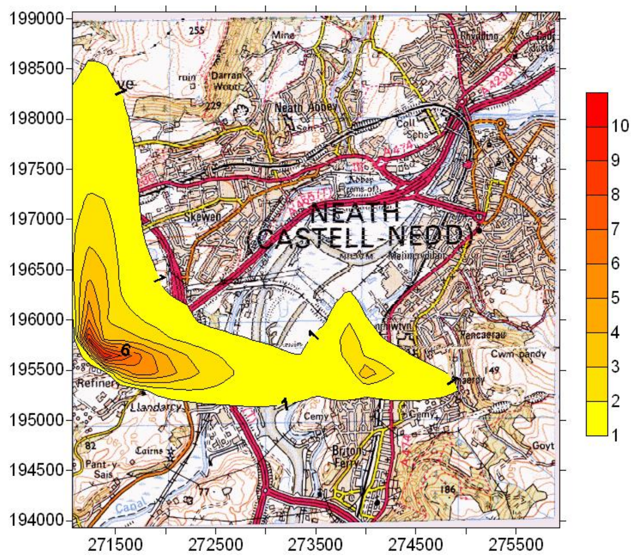


Figure D.12 – Contour plot of concentration overlaid on a base map.

Once the plot has been produced, you may wish to modify the map extent, change its scale, or modify the layout (colour-filled contours). If colour-filled contours are chosen, they should be made transparent so that the map underneath is visible. Refer to Section D.4 for an explanation of how to do this.

D.4 Customise a map

The easiest way to customise a feature present on a contour, surface or post map is to click on that feature in the **Contents** window (tick the **Contents** checkbox in the **View** tab if this window is not visible) to access the **Properties** window for it (similarly, tick the **Properties** checkbox if this window is not visible). Modifications can be applied to the map by editing the information in the various tabs of the **Properties** window.

This section contains explanations of how to edit and modify the most common features of the map (contour levels, colour, pattern and labels; line colour, thickness and pattern; colour scale; axes and grid lines; map scale and extent). The examples will use the contour map shown in **Figure D.13** and the contour map overlaid on the surface map shown in **Figure D.12**.

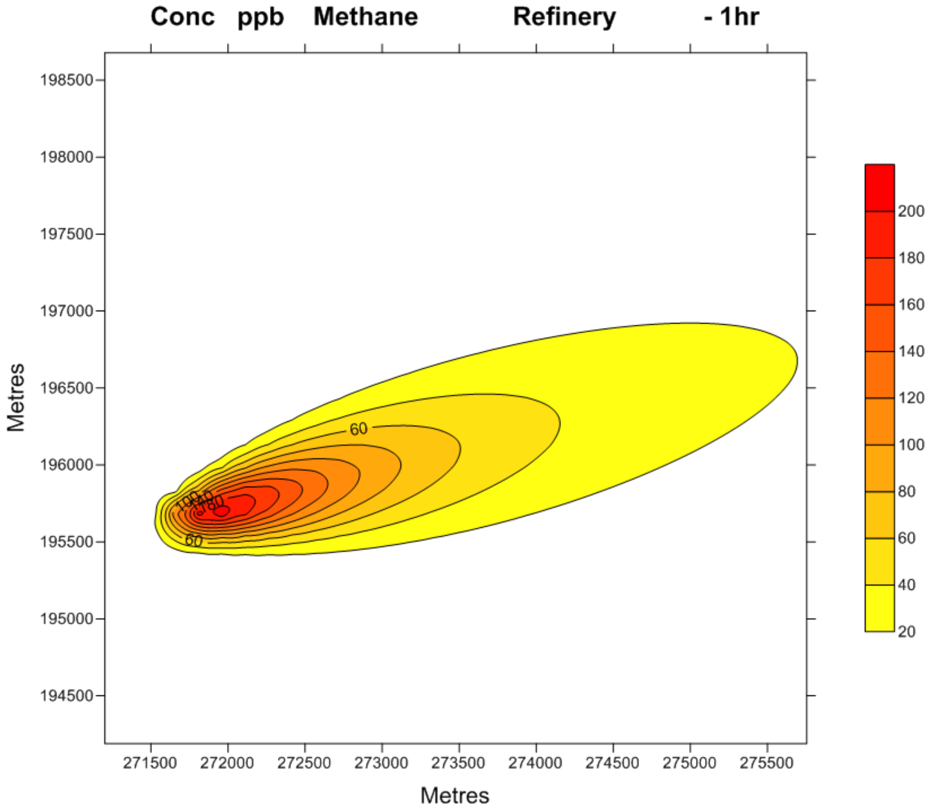


Figure D.13 – Example of contour plot of concentrations.

To access the properties of the contour map, click on **Contours** (or **ContourPlot** if created via the contour plotter) in the **Contents** window.

D.4.1 Levels

Levels can be edited by selecting the **Levels** tab in the **Properties** window for the contours. Simple modifications can be made by editing the values shown, but more advanced manipulation can be performed by clicking on the box next to the **Level method** item and selecting **Advanced** from the drop down menu. Clicking on **Edit Levels...** brings up a dialogue box for editing the levels properties, as shown in **Figure D.14**.

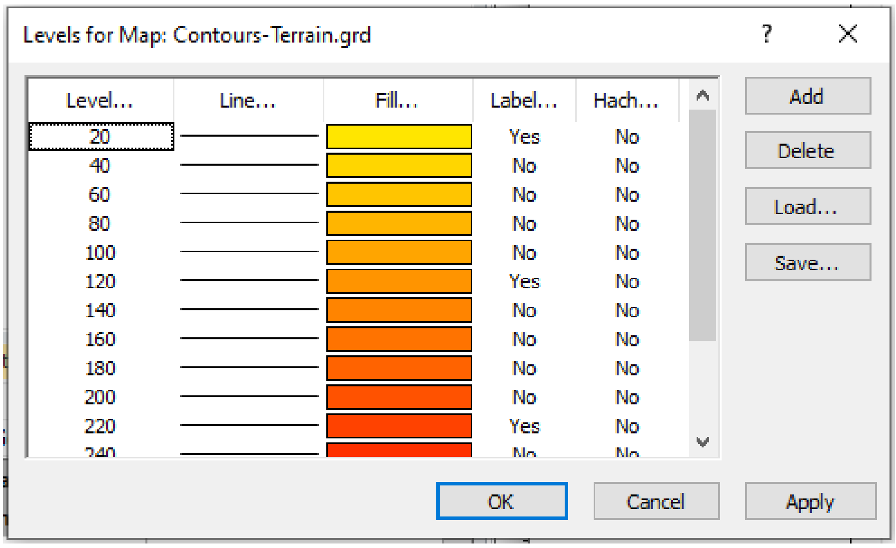


Figure D.14 – **Levels** editor screen.

The contour levels can be edited in three ways:

- *All existing levels together*: click on the **Level...** button on top of the level column to specify regular intervals. This may have changed the colours of the filled contours to a grey/black scheme but colour scheme and pattern can easily be changed.
- *One existing level at a time*: double-click on the value of the level to edit and change the value to the one you want.
- *Add a level between two existing ones*: to add a new contour level (e.g. 170 in **Figure D.14**), click on the next highest level (180 in this case) and then on the **Add** button. The new contour will be added, i.e. the halfway value between the one you clicked on (180) and the one below it (160).

Once you are happy with the contour levels that are shown in the contour plot, you can save them in a level file (*.lvl*) in order to re-use the configuration for other plots, for example plots you want to compare to each other. Click on **Save...** and save the level file with a unique name. This will not only save the contour levels but also the choice of colours, pattern of the filled contours, labels, line thickness and colour, label fonts, etc. (i.e. most of the parameters that can be edited in **Figure D.14**).

To apply an existing level file to a contour plot, select **Advanced** from **Level method** and click on **Edit Levels...** as described above to bring up the properties dialogue box. Click on the **Load...** button, and select the particular *.lvl* file required.

D.4.2 Contour colour and pattern

To edit the colour and pattern of contour maps, select **Edit Levels...** as described before to access the screen shown in **Figure D.14**. Click on the **Fill...** button at the top of the fill column to open the screen shown in **Figure D.15**.

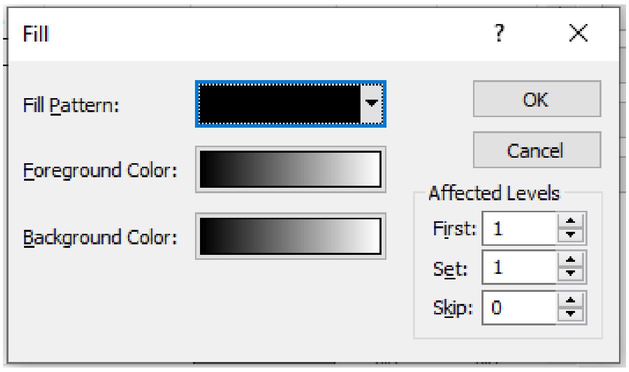


Figure D.15 – Setting the spectrum of colours and patterns for the contour plot.

By default, the pattern style is solid but other patterns such as lines, checks, etc., are available. For some patterns the choice will become available to make the pattern either **Opaque** or **Transparent**.

Click on the **Foreground Color** coloured box to access the screen shown in **Figure D.16**. In this **Colormap Editor** screen, you can choose the colours of the minimum and maximum contour levels as well as those for any intermediate level. The result will be a ramp of colours ranging from the minimum to the maximum colour (passing through intermediate level colours if specified).

You must make sure that the ***Fill Contours*** *box is checked in the* ***Levels*** *tab of the* ***Properties*** *window for the* ***Contours*** *layer in order for the colours to appear on the contour plot. If you just want a contour plot with labelled contour lines then leave this box unchecked.*

Alternatively, the user can specify a unique colour for every contour level. Similarly to the level values, each individual colour can be edited by double-clicking on the coloured box.

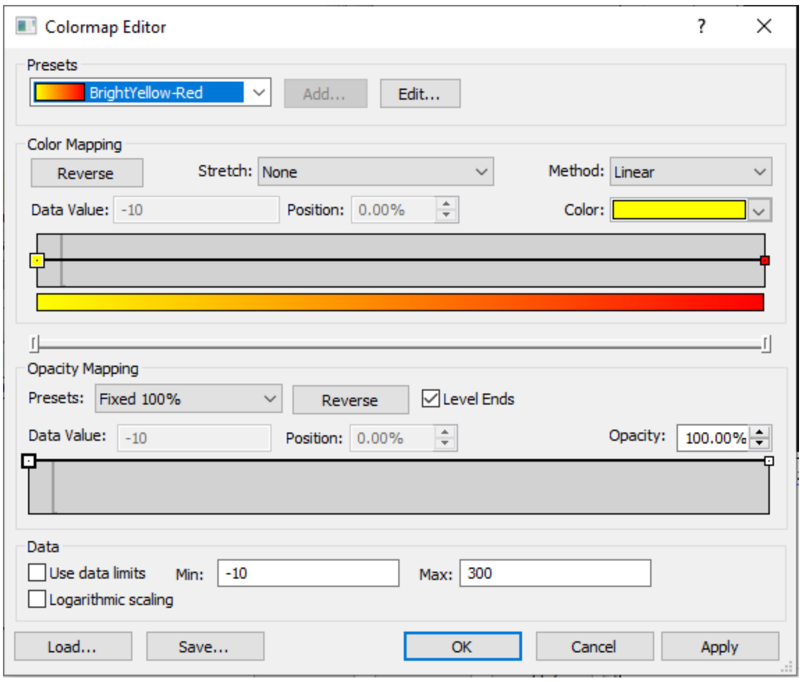


Figure D.16 – Choosing colours for filling contours.

Transparent colour-filled contours

Transparency is needed when you overlay a contour map of concentrations on a base map. Solid colour is used by default for the contours and the map underneath is not visible.

To set the transparency of colour-filled contours, select the contour layer in the **Contents** window, click on the **Layer** tab in the **Properties** window, and use the **Opacity** slide bar to set the transparency to the desired level.

Figure D.17 gives an example of a transparent filled-colour contour plot of concentration overlaid on a digital base map.

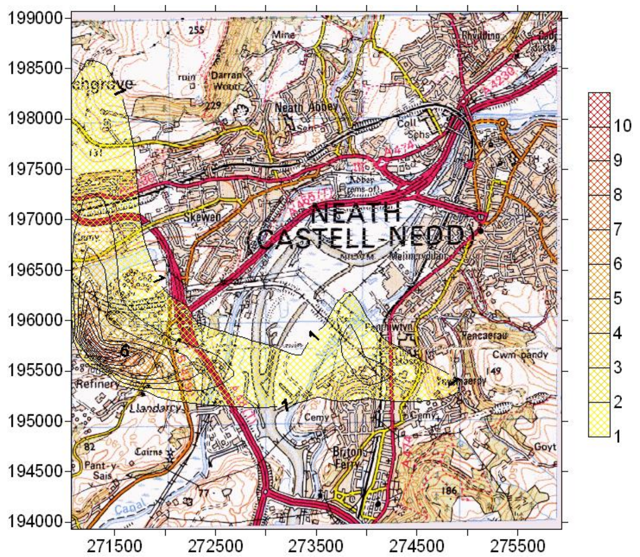


Figure D.17 – Example of transparent filled-colour contour plot of concentration overlaid on a digital base map.

D.4.3 Line colour, thickness and pattern

Colour, thickness and pattern of some or all the contour lines in the Surfer plot can be modified. To do so, in the levels editor screen shown in **Figure D.14**, click on the **Line...** button at the top of the line column to access the line properties. By default the lines are solid black lines but their colour, pattern and thickness can be modified. The lines can all be the same colour and thickness, they can ramp from minimum to maximum attributes or each have a unique colour and thickness.

D.4.4 Contour labels

To change the labelling format, in the levels editor screen shown in **Figure D.14** click on the **Label...** button at the top of the label column to access the properties of the contour labels.

The labelling frequency can be edited so as to label every line, every two lines, etc. The format and font of labels can also be adjusted: the size or colour changed, decimal digits added, exponential format selected (for example, for very small numbers) etc.

D.4.5 Colour scale

When a contour plot has filled-colour contours, it is useful to include a colour scale on the plot. This is included by default when contour plots are generated from the **2-D Output Plotter (Plotting in Surfer)** utility. For user-generated contour plots, the colour scale can be added to the plot by ticking the **Color Scale** checkbox in the **Levels** tab of the contour layer's **Properties** window. To change the format of these labels click on the colour scale bar on the contour plot to access its **Properties** window. The label format and font can be changed using the options in the various tabs.

D.4.6 Axes and grid lines

In order to access the properties of an axis, click on the axis to display the setting in the **Property Manager** window. A number of features can be edited here, such as the label format and angle, the ticks, the scale of the plot, and the grid lines.

It can be very useful to have grid lines at specific intervals on top of the contour map, and an example is shown in **Figure D.18**.

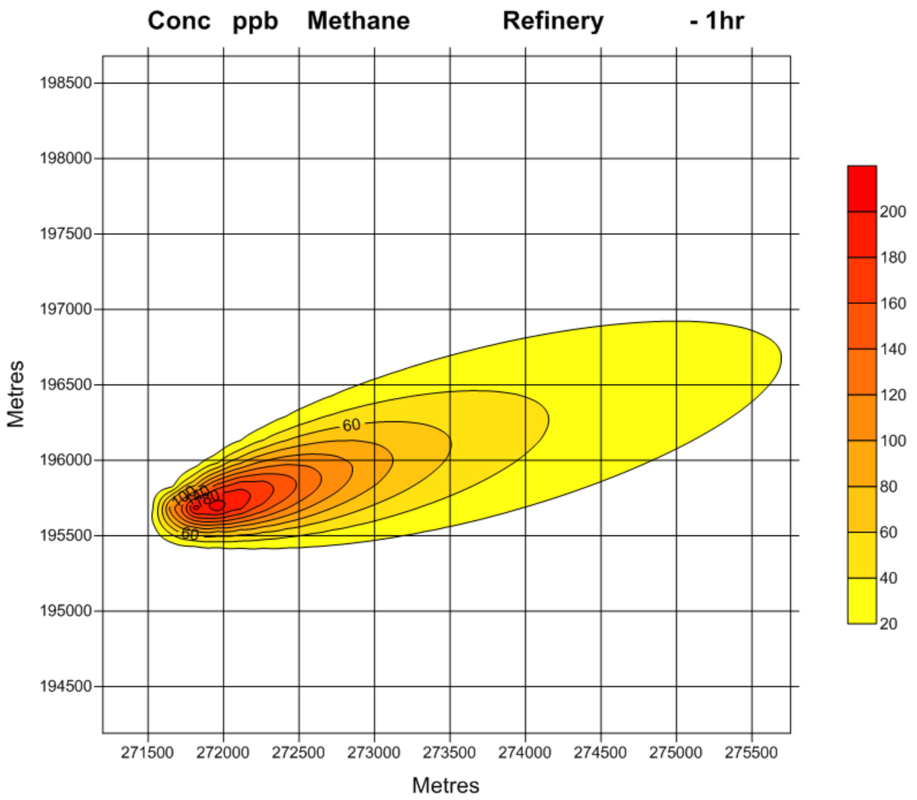


Figure D.18 – Use of grid lines superimposed on contour plot.

In the **Properties** window, click on the **Grid Lines** tab and check the **Show** check box of the **Major Grid Lines** (and **Minor Grid Lines** if you wish the minor grid lines to be shown too). The grid lines properties (style, colour, width) can be modified by clicking on the button showing the line. Major and minor grid line intervals are defined by the major interval of the axis label (**Scaling** tab) and the minor ticks options (**Ticks** tab).

D.4.7 Scale and extent

If you want the map to occupy more or less of the page then you can change the scale or stretch the map by dragging one of the corners. To modify the scale of a map, click on **Map** in the **Contents** window to view the **Properties** window for it and select the **Scale** tab. The **Proportional XY Scaling** option is useful to maintain the same scales in both X and Y directions.

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*When you open the **Properties** window for the scale and extent, the units for the X and Y scales may be in map units per inch. To change this to centimetres, go to **File**, **Options** and change the **Page Units** under the **General** menu.*

Extent of a base map

It is often useful to make the base map extent a little larger than the extent of the contour map so that the surrounding land use can be viewed, or to zoom in on one particular area of the map.

To do this, click on **Map** in the **Contents** window to view the **Properties** window for it, select the **Limits** tab and indicate the new limits. Note that the scale is automatically at the scale of the original base map.

APPENDIX E Useful Contacts

This appendix contains information on:

1. ADMS-Screen: contact, Helpdesk, support contracts;
2. where to obtain meteorological data for ADMS-Screen;
3. visualisation tools for ADMS-Screen: Surfer, ArcGIS, MapInfo; and
4. official organisations.

E.1 ADMS-Screen contact information

ADMS Helpdesk

Tel: (01223) 357 773 – ask for ADMS Helpdesk
Email: help@cerc.co.uk Website: cerc.co.uk

This service is available to those with valid support contracts (see below) between the hours of 9.30am and 5.00pm (GMT in winter, BST in summer), Monday to Friday (excluding UK public holiday periods and the period 25th December to 1st January).

Support contract

A valid support contract entitles the user to

- use of the ADMS Helpdesk;
- model upgrades;
- access to further technical advice and downloads on the User Area of the CERC website cerc.co.uk/software-support/user-area.php;
- regular newsletters; and
- participate in the user survey, which helps steer future model developments.

All annual licence holders are entitled to support during the period of the licence.

Scope of the ADMS Helpdesk service

The scope of the ADMS Helpdesk Service is to provide answers to specific questions about using ADMS-Screen, such as *"How do I model building effects?"*, to respond to any reported error messages that occur while running the model, and to record and report on any issues found. Where appropriate, CERC staff can also provide advice on setting up particular modelling scenarios and advice on interpreting the results.

Surfer, ArcGIS and MapInfo problems should be directed to Golden Software, ESRI and MapInfo, respectively.

E.2 Contact details for ADMS-Screen input data

Meteorological data

Meteorological data should be ordered in a format suitable for input into ADMS-Screen. Most ADMS-Screen users will require hourly sequential data for one or more years.

For the UK, meteorological data in ADMS format are available from a variety of suppliers, including the UK Met Office (metoffice.gov.uk). Hybrid datasets combining, for example, wind speed and direction from one location with cloud cover data from another may be appropriate; users are advised to discuss such options with their provider.

For France, meteorological data are available from Météo France (meteofrance.com). Supplied data include wind speed and direction measured at 10 m in height (for the last 10 minutes of each hour), temperature, cloud cover (note that it is usually measured only at the main station of each département, and that very often numerous night data are missing), and rainfall.

Background data

Background concentration data for a wide range of sites in the UK are available from the UK National Air Quality Information Archive website

uk-air.defra.gov.uk/data/data_selector

Background data may also be available from local authorities

E.3 Output visualisation tools

Surfer

Golden Software, LLC.
PO Box 281
Golden
CO 80402-0281
U.S.A.

Tel: +1 (303) 279 1021
Email:info@goldensoftware.com or surfersupport@goldensoftware.com
Web: goldensoftware.com

ArcGIS

For queries about ArcGIS, contact the local ESRI distributor for your country (details may be obtained from esri.com).

For the UK, the local distributor is:

ESRI (UK) Ltd.
Millennium House
65 Walton Street
Aylesbury
HP21 7QG
United Kingdom

Tel: +44 (0)1296 745 500
Email:sales@esriuk.com
Web: esriuk.com

MapInfo

For queries about MapInfo, contact the local MapInfo distributor for your country

precisely.com/product/precisely-mapinfo/mapinfo-pro

E.4 Official organisations

Department for Environment, Food and Rural Affairs (Defra)

Defra is responsible for the UK air quality strategy.

Web: gov.uk/government/organisations/department-for-environment-food-rural-affairs

Environment Agency (EA)

The Environment Agency regulates air quality in England.

Web: gov.uk/government/organisations/environment-agency

Scottish Environment Protection Agency (SEPA)

SEPA regulates air quality in Scotland.

Web: sepa.org.uk

Natural Resources Wales (NRW)

NRW regulates air quality in Wales.

Web: naturalresourceswales.gov.uk

Northern Ireland Environment Agency (NIEA)

The NIEA regulates air quality in Northern Ireland.

Web: daera-ni.gov.uk/northern-ireland-environment-agency

European Environment Agency (EEA)

Web: eea.europa.eu

World Health Organization (WHO)

Web: who.int

APPENDIX F References

This is the main reference list for this User Guide, in particular Section 9.

Validation studies

ADMS-Screen uses the same model code as the more complex industrial dispersion model ADMS 6, which has been validated against a number of data sets. The model results have been compared to observational data or other model results if available. Documents or presentations containing results of ADMS 6 validation can be found on the CERC website cerc.co.uk.

The full ADMS 6 Technical Specification is available from the CERC website at the address cerc.co.uk/environmental-software/technical-specifications.html.

Published technical papers

The following publications provide additional technical information on the ADMS 6 model, its validation and application.

Carruthers, D.J., Edmunds, H.A., Lester, A.E., McHugh, C.A. and Singles, R.J., 2000: Use and validation of ADMS-Urban in contrasting urban and industrial locations. In *Int. J. Environment and Pollution*, **14**, pp. 364-374.

Carruthers, D.J., Dixon, P., McHugh, C.A., Nixon, S.G. and Oates, W., 2001: Determination of Compliance with UK and EU Air Quality Objectives From High-Resolution Pollutant Concentration Maps Calculated Using ADMS-Urban. In *Int. J. of Environment and Pollution*, **16**, pp. 460-471.

Carruthers, D.J., Dyster, S. and McHugh, C.A., 2000: Contrasting methods for validating ADMS using the Indianapolis dataset. In *Int. J. Environment and Pollution*, **14**, pp. 115-121.

Carruthers, D.J., Dyster, S. and McHugh, C.A., 2003: Factors affecting interannual variability of NO_X and NO_2 concentrations from single point sources. In *Clean Air and Environmental Protection*, **33**, 1, pp. 15-20.

Carruthers, D.J., Edmunds, H.A., Bennett, M., Woods, P.T., Milton, M.J.T., Robinson, R., Underwood, B.Y. and Franklyn, C.J., 1995: Validation of the UK-ADMS Dispersion Model and Assessment of its Performance Relative to R91 and ISC using Archived LIDAR Data. Study commissioned by Her Majesty's Inspectorate of Pollution, published by DoE. DoE/HMP/RR/95/022.

Carruthers, D.J., Holroyd, R.J., Hunt, J.C.R., Weng, W-S., Robins, A.G., Apsley, D.D., Thomson, D.J. and Smith, F.B., 1994: UK-ADMS: a new approach to modelling dispersion in the Earth's atmospheric boundary layer. In *J. of Wind Engineering and Industrial Aerodynamics*, **52**, pp. 139-153.

Carruthers, D.J., Holroyd, R.J., Hunt, J.C.R., Weng, W-S., Robins, A.G., Apsley, D.D., Smith, F.B., Thomson, D.J. and Hudson, B., 1991: UK Atmospheric Dispersion Modelling System. In *Proceedings of the 19th NATO/CCMS International Technical Meeting on Air Pollution Modelling and its Application, September 1991, Crete, Greece*. Eds. Han van

Dop and George Kallos, Plenum Publishing Corporation, New York.

Carruthers, D.J., McKeown, A.M. and McHugh, C.A., 1997: Air dispersion study of options for abatement of SO_2 emissions at Castle Cement, Clitheroe. In *Environment Agency Report NW-9/97-25/B-BADQ.*

Carruthers, D.J., McKeown, A.M., Ellis, K.L. and McHugh, C.A., 1997: Air dispersion climate from the Castle Cement Works at Ribblesdale. In *Environment Agency Report NW-7/97-20-BAZSQ.*

Carruthers, D.J., McKeown, A.M., Hall, D.J. and Porter, S., 1999: Validation of ADMS against wind tunnel data of dispersion from chemical warehouse fires. In *Atmospheric Environment*, **33**, pp. 1937-1953.

CERC, 1998: Turbulence, Fluctuations and Averaging Times. CERC Technical Note, 22 December 1998.

CERC, 2023: ADMS 6 Technical Specification.

Dyster, S.J., Thomson, D.J., McHugh, C.A. and Carruthers, D.J., 2001: Turbulent Fluctuations and Their Use in Estimating Compliance Standards and in Model Evaluation. In *Int. J. of Environment and Pollution,* **16**, pp. 57-68.

Fackerell, J.E. and Robins, A.G., 1982: Concentration fluctuations and fluxes in plumes from point sources in a turbulent boundary layer. In *J. Fluid Mech.*, **117**, pp. 1-26.

Hunt, J.C.R., Holroyd, R.J., Carruthers, D.J., Robins, A.G., Apsley, D.D., Smith, F.B. and Thomson, D.J., 1990: Developments in Modelling Air Pollution for Regulatory Purposes. In *Proceedings of the 18th NATO/CCMS International Technical Meeting on Air Pollution Modelling and its Application,* Vancouver, Canada.

Irwin, J.S., Carruthers, D.J., Stocker, J., and Paumier, J., 2003: Application of ASTM D6589 to evaluate dispersion model performance. In *Int. J. Environment and Pollution*, **20**, pp. 4-10.

McHugh, C.A., Carruthers, D.J., Higson, H. and Dyster, S.J., 1999: Comparison of Model Evaluation Methodologies with Application to ADMS 3 and US Models. Paper 58 in *Proceedings of the 6th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Rouen, 11-14 October 1999*.

Pasquill, F. and Smith, F.B., 1983: Atmospheric Diffusion - Study of the dispersion of windborne material from industrial and other sources. Third edition. Ellis Horwood Ltd, Chichester.

Robins, A. and McHugh, C.A., 2001: Development and Evaluation of the ADMS Buildings Effects Module. In *Int. J. of Environment and Pollution,* **16**, pp. 161-174.

Thomson, D.J., 1990: A stochastic model for the motion of particle pairs in isotropic high-Reynolds number turbulence and its application to the problem of concentration variance. In *J. Fluid Mech.*, **210**, pp. 113-153.

Thomson, D.J., 1997: The ‘inertial-meander’ sub-range of a dispersing plume. In *J. Applied Meteorology*, **36,** pp. 1046-1049.

Timmis, R., Wilkinson, S., Carruthers, D.J. and McHugh, C.A., 2000: Recent Studies to Validate and Compare Atmospheric Dispersion Models for Regulatory Purposes in the UK. In *Int. J. of Environment and Pollution,* **14**, pp. 431-442.

Others

The following publications are references to papers and reports on dispersion relevant to the technical content of ADMS 6.

Azzi, M., Johnson, G. and Cope, M.E., 1992: An Introduction to the Generic Reaction Set Photochemical Smog Mechanism. In *Proceedings of the 11th International Conference of the Clean Air Society of Australia and New Zealand (Brisbane, Australia, July 1992*), **2**, pp. 451-462. Eds. P. Best, N. Bofinger, D. Cliff.

Beljaars, A. C. M., 1994: The parameterisation of surface fluxes in large-scale models under free convection. In *Quart. J. R. Met. Soc.*, **121**, pp. 255-270.

Bevilaqua, P.M. and Lykoudis, P.S., 1978: Turbulence memory in self-preserving wakes. In *J. Fluid Mech.*, **89**, pp. 589-606.

Briggs, G.A., 1969: *Plume Rise*. U.S. Atomic Energy Commission Div. Tech. Inf.

Briggs, G.A., 1985: Analytical parameterizations of diffusion - the convective boundary layer. In *J. Clim. Appl. Met.*, **14**, pp. 1167-1186.

Carruthers, D.J., Hunt, J.C.R. and Weng, W.-S., 1988: A computational model of stratified turbulent airflow over hills - FLOWSTAR I. In *Computer Techniques in Environmental Studies*, pp. 481-492. Ed. P. Zanetti, Springer-Verlag.

Caughey, S.J. and Palmer, S.G., 1979: Some aspects of turbulence structure through the depth of the convective boundary layer. In *Quart. J. R. Met. Soc.*, **105**, pp. 811-827.

Cimorelli, A.J, Perry, S.G., Venkatram, A., Weil, J.C., Paine, R.J., Wilson, R.B., Lee, R.F., Peters, W.D., Brode, R.W. and Paumier, J.O., 2004: AERMOD Description of Model Formulation. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division, Research Triangle Park, EPA-454/R-03-004.

Clarke, R.H., 1979: A model for short and medium range dispersion of radionuclides released into the atmosphere. NRPB Report NRPB-R91.

Davies, B.M., Jones, C.D., Manning, A.J. and Thomson, D.J., 2000: Some field experiments on the interaction of plumes from two sources. In *Quart. J. R. Met. Soc.*, **126**, pp. 1343-1366.

DiNenno, P.J., Beyler, C.L., Walton, W.D., Custer, R.L.P. and Watts, J.M. (ed.), 1988: SFPE Handbook of Fire Protection Engineering. Society of Fire Protection Engineers, Boston, MA.

Drysdale. D., 1999: An Introduction to Fire Dynamics. Second edition. John Wiley & Sons.

Fannelöp, T.K., 1994: Fluid Mechanics for Industrial Safety and Environmental Protection. Elsevier, Industrial Safety Series, Vol. 3.

Fischer, H.B., List, E.J., Koh, R.C.Y., Imberger, J. and Brooks, N.H., 1979: Mixing in Inland and Coastal Waters. Academic Press.

Gray, D.E. (ed.), 1972: American Institute of Physics Handbook (third edition). McGraw-Hill, New York.

Hanna, S.R., Briggs, G.A. and Hosker, R.P., 1982: Handbook of Atmospheric Diffusion. US Dept of Energy office of Scientific and Technical Information Publication DOE/TIC-22800.

Hanna, S.R. and Paine, R.J., 1989: Hybrid plume dispersion model (HPDM) development and evaluation. In *J. Appl. Meteorol.*, **28**, pp. 206-224.

Hanna, S.R., Egan, B.A., Purdum, J. and Wagler, J., 1999: Evaluation of ISC3, AERMOD and ADMS dispersion models with observations from five field sites. Hanna Consultants Report P020. Fairfax, VA.

HMIP, 1993: Guidelines on Discharge Stack Heights for Polluting Emissions. Environmental Protection Act 1990, Technical Guidance Note (Dispersion) D1, June 1993. HMSO.

Holtslag, A.A.M. and van Ulden, A.P., 1983: A simple scheme for daytime estimates of the surface fluxes from routine weather data. In *J. Clim. Appl. Met.*, **22**, pp. 517-529.

Hunt, J.C.R., 1985: Turbulent diffusion from sources in complex flows. In *Ann. Rev. Fluid Mech.*, **17**, pp. 447-458.

Hunt, J.C.R., Holroyd, R.J and Carruthers, D.J., 1988a: Preparatory studies for a complex dispersion model. CERC Report HB9/88.

Hunt, J.C.R., Leibovich, S. and Richards, K.J., 1988b: Turbulent shear flow over hills. In *Quart. J. R. Met. Soc.*, **114**, pp. 1435-1470.

Hunt, J.C.R., Richards, K.J. and Brighton, P.W.M., 1988c: Stably stratified flow over low hills. *Quart. J. R. Met. Soc.*, **114**, pp. 859-886.

Hunt, J.C.R., Stretch, D.D. and Britter, R.E., 1988d: Length scales in stably stratified turbulent flows and their use in turbulence models. In *Proceedings IMA Conference on Stably Stratified Flow and Dense Gas Dispersion*, pp. 285-322. Ed. J.S. Puttock, Clarendon Press.

Lakes Environmental Consultants Inc., 2003: Flare sources. In *Proposed guidance for air dispersion modelling*, p. 22. Ontario Ministry of the environment.

Lamb, R.G., 1982: Diffusion in the convective boundary layer. In *Atmospheric Turbulence and Air Pollution Modelling*, pp. 159-230. Eds. F.T.M. Nieuwstadt and H. van Dop, D. Reidel, Dordrecht.

Lawson, R.E., Snyder, W.H. and Thompson, R.S., 1989: Estimation of maximum surface concentrations from sources near complex terrain in neutral flow. In *Atmospheric Environment*, **23**, pp. 321-331.

Moore, D.J. and Lee, B.Y., 1982: An asymmetrical Gaussian plume model. Central Electricity Generating Board Report RD/L/2224N81.

Nuffield Science Foundation, 1984: Nuffield Advanced Science - Book of Data. First revised edition. Longman.

Oke, T.R., 1987: Boundary layer climates. Second edition. Methuen.

Panofsky, H.A. and J.A. Dutton, 1984: Atmospheric Turbulence, Models and Methods for Engineers and Scientists. John Wiley and Sons, New York.

Perry, S.G., 1991: CTDMPLUS: A dispersion model for sources near complex topography. Part I: Technical formulations. In *J. Appl. Meteor.*, **31**, pp. 633-645.

Snyder, W.H. and Lawson, R.E., Jr., 1991: Fluid modelling simulation of stack-tip downwash for neutrally buoyant plumes. In *Atmospheric Environment*, **25A**, pp. 2837-2850.

U.S. E.P.A., 1995: User's Guide for the Industrial Source Complex (ISC3) Models. Volume I: User Instructions (Report EPA-454/B-95-003a) ; Volume II: Description of model algorithms (Report EPA-454/B-95-003b), September 1995. U.S. E.P.A., Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division, Research Triangle Park, NC 27711.

van Ulden, A.P. and Holtslag, A.A.M., 1985: Estimation of atmospheric boundary layer parameters for diffusion applications. In *J. Clim. Appl. Met.*, **24**, pp. 1194-1207.

Venkatram, A., 1977: Internal boundary-layer development and fumigation. In *Atmospheric Environment*, **11**, pp. 479-482.

Venkatram, A., Karamchandani, P., Pai, P. and Goldstein, R., 1994: The Development and Application of a Simplified Ozone Modelling System (SOMS). In *Atmospheric Environment*, **28**, pp. 3665-3678.

Weil, J.C., 1985: Updating applied diffusion models. In *J. Clim. Appl. Met.*, **24**, pp. 1111-1130

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