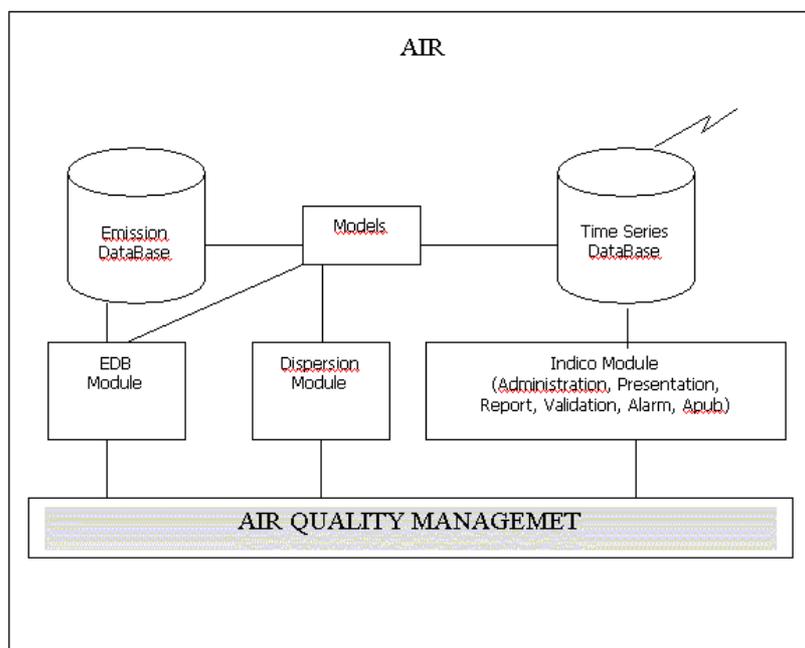


# Apertum

## Airviro Specification



## Airviro Specification v4.00

### Part I: Functions in Airviro

## Part I: Functions in Airviro

### Amendments

Version	Date changed	Cause of change	Signature
3.00.11	040517	Modifications made to feet version 3.00 of Airviro	GS
3.00.11	040518	US EPA ISC Aermod description add in dispersion	GS
3.00.11	040609	Emission Estimation & Source Location Modules Added	GS
3,20	041010	New Release	GS
4.00	112817	New version	GS
4.00	180904	Review	GS

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# 1. Introduction

Airviro 4.00 uses a Web based interface that makes it a three tier, distributed client / server system suitable for regional and corporate solutions.

Airviro is a tool for analysis, planning and decision-making in the management of air. The system is built around the following basic parts:

- databases for
  - monitored data
  - emissions to the air environment
  
- user interface modules for
  - handling data collection
  - analysis, presentation of time series data
  - editing and checking data in the time series database
  - Viewing, editing and checking the contents of the time series database and validate the data.
  - Execute different dispersion models
  - Execute different reports and export time series data
  - Using alarms.
  - Environmental data Publishing on the Internet. Showing real time data or historical data for a selected period.

Airviro is divided up into several different self-contained modules. An Airviro installation can consist of just one of these modules, although usually a combination of modules is chosen.

The software has been designed so that

- it can be fully operated using easy-to-use windows and menus
- results are presented clearly and informatively, mostly on background maps

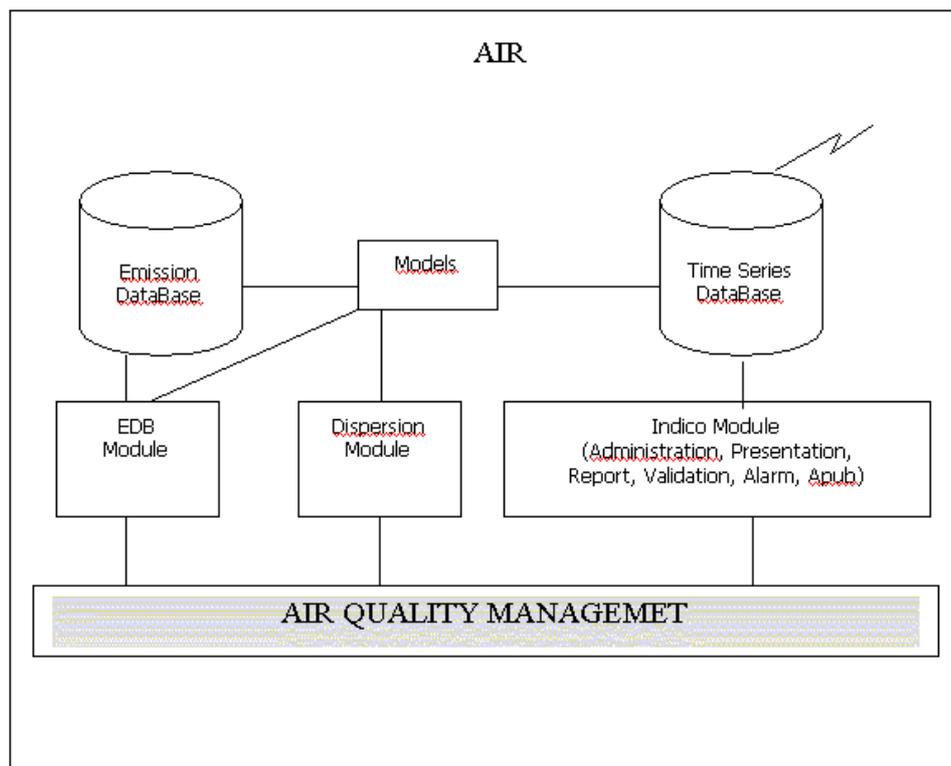


Figure 1: Overview of Airviro

## 1.1. Airviro Documentation

The user documentation for Airviro includes the following documents:

- *Users Reference*: A manual using detailed examples showing how the modules in the system can be applied to different problems occurring in air quality management work, including references to relevant literature
- *Airviro Specification* (this document): A detailed description of the functions and properties of the system.

## 1.2. Structure of Airviro Specification

The Airviro Specification is divided into two parts. Part I is an overview of the different functions in Airviro, and mainly describes everything that can be done using the menu driven user interface. Part II consists of appendices containing more detailed information such as how to import and export data, how the underlying databases are formed and how the dispersion models work. The relevant sections in Part II are referred to in Part I, although to get a general idea of the functions of Airviro it is sufficient to read Part I.

Airviro is divided into different modules, and different parts of different modules are required, depending on what the system is to be used for. Each module is described separately in Part I of this document, first describing the basic functions that are always

provided when the module is purchased and then describing the other options available with the module.

### **1.3. Airviro Delivery**

A typical Airviro delivery will include the following:

- Agreement on input data content and format (Domain REF) as well as delivery schedule and specification of data collection.
- Preparation of input data (data requirements are described in Appendix D3.2 "Necessary Geographical Information for Airviro" and D3.4 "Necessary Weather Information for Airviro")
- Recommendation in the installation of meteorological equipment
- Installation and configuration of linux server and workstations
- Training
- Acceptance test at customer site

## 2. Introduction to Airviro

### 2.1. Introduction

The user interface for Airviro 4.00 is a web browser designed to be easy to work with. The entire user interface runs in the browser.

The data are imported using the Waved, Wedbed or the ASCII interfaces in the system.

Import and exports of shape files are used in Airviro as well.

### 2.2. Basic Functions

On delivery an Airviro system is ready to work with. The different modules are easily accessed via the Airviro main page. Each module has the Airviro User Reference available on the web server (Domain: REF). An error log is also included for maintenance purposes.

If any time series data is to be included the system must also be complemented with a time series database and related databases.

### 2.3. Hardware and Software

Airviro 4.00 is a three tier client / server web system. The clients normally run on PCs using JAVA JRE (run time plugin) compatible web browsers such as Internet Explorer 6 or later and Firefox.

The web server side is using lean CGI scripts and heavy programs written primarily in C. The pages at the client side use html and java script and are built on the server. Some small applets written in Java v1.1 are also used on the client side primarily for caching, maps and user interfaces that are to complex to be written using html and JavaScript.

All models are written using FORTRAN.

The whole web solution has been designed to work with low bandwidth connections such as modems.

The Airviro databases are based on the FairCom CTREE™ server version 4.3 or on proprietary solutions.

### 2.4. User Privileges

In Airviro 4.00 several domains can exist. Each domain normally contains information regarding a city or province. For each domain, privileges to control access and write privileges to the different modules can be set up on a per user basis.

Roles can be created in order to group users together. If roles are used the privileges are specified per role and affect all the users that are members of that role.

It is possible to assign different privilege levels to different system users, and to specify default privilege levels. These privilege levels affect usage of different emission databases, ability to edit databases via the Indico modules and the ability to edit time series data. Different users can be assigned different privilege levels.

The IADM module allows the Airviro users, to perform some administrative and configuration tasks in Airviro. Maps and climatology can also be configured using this module

## **2.5. Licence Manager**

With Airviro 4.00 two kinds of licenses exist: LAN and Internet licenses. The LAN license restricts the access to clients that have the same class C Internet address as the Airviro server. The clients must be on the same network as the server, dial up connections to the server are prohibited and access via a proxy server that changes the IP address of the clients IP address are prohibited as well.

The Internet licenses allow 15 external physical users (persons) to access the server. If more Internet licenses are needed a new 15 user Internet license must be bought.

For more information see Appendix D1.2 "Licence Manager".

## 3. Emission Database (EDB) for Ambient Air Emissions

### 3.1. Introduction

The Emission Database (EDB) includes structures designed to maximise the ease with which available knowledge about ambient air emission sources can be included in the system. The EDB has no real time connection, unless sources have their emission defined as time series, because the aim of the database is to synthesise existing information for all emissions of interest to air quality management. This includes not only historic data but also information for prognostic purposes.

An emission database can contain any number of sources and user can create any number of emission databases. In this way the number of emission databases in a system is unlimited.

The tables provided enable the user to describe the following information for each source:

- time variation of emission
- impact of outdoor temperature on emission
- emission factors for types of fuels and groups of substances
- different road types
- emission factors for vehicle types describing traffic variations with speed and time

The emission database stores information for four different types of sources:

- point sources
- ships sources
- facilities sources
- area sources
- road sources
- grid layers

In addition to the link to dispersion modelling, the emission calculations of magnitudes and distribution are themselves of interest and may be presented in different forms (see 3.2.4 "Output from the EDB").

Within the Airviro environment, the dynamic EDB can be directly linked to the dispersion models, allowing the user to combine different emission scenarios with various dispersion conditions. For more information on the structure of the EDB refer to Appendix C3 "The Emission Database and Associated Databases".

It is possible to have more than one emission database within the EDB module. A global EDB is available, but all users may in addition have their own personal EDBs for working and testing. An overview of the data flow in an EDB can be seen in Figure 2 (pag 18).

An additional product, Wedbed, that is a plug in to Excel permits entire EDB:s to be transferred and stored in Excel sheets. After altering the EDB:s in Excel they can be transferred back to Airviro. See *Appendix 1D Wedbed. Working the EDB . Airviro User's Reference* for more information.

Noise factors can be added to road links and a noise emission map can be presented. The noise emission is presented as colored links.

## 3.2. Basic functions

### 3.2.1. Storage of Source Data

**Point sources** include the following information:

- **General information** such as the name of the company, address, contact person, date of entry and date of last change. This information is needed to maintain the database.
- **Static information** such as chimney height, inner and outer diameter of the chimney, exhaust gas temperature, coordinates and the influence of any nearby buildings. These figures do not affect the emission strength, nor do they vary over the year, but they are required in order to describe the characteristics of the initial pollutant plume. This type of information is vital for the dispersion simulations. It is also possible to specify data for buildings surrounding the source. This building data is used by the US EPA AERMOD dispersion model.
- **Dynamic information** is the information that directly controls the emission, such as formulae that describe the emission as a function of outdoor temperature, or as a function of day type and hour, etc. Formulae are defined that describe time and temperature variation tables. The emission variations defined in the formulae are interpreted in two principal ways as a consequence of linking either a substance, a substance group or a fuel to a formula. A formula connected to a source type where the emission is described in terms of a fuel also includes a description of the variation of exhaust gas velocity in terms of the fuel consumption (effect).
- **Search keys:** It is possible to define five groups of search keys in order to structure the emitters into groups that can be used to separate the total emissions.

**Area sources** are stored in the same way as point sources except that no static information is used. The emission is assumed to be evenly distributed over the whole area source at a height of 2 metres above the ground. All area sources are rectangular.

**Road sources** are stored in the database as vector chains. Each road source must be linked to a particular road type, which describes the yearly, monthly and daily traffic pattern, speed restrictions and the vehicles that use the road. Road sources can also be linked to the five groups of search keys. The emission from a road source is assumed to be evenly distributed along a line at a height of 2m above the ground.

**Ships:** are stored in the database as ships ( boats, ferries, mercant ships, cargo ships, etc.). Each ship as mobile point source describes coordinates, velocity and a unique ship identifier.

**Facilities:** several point/area several point sources can be related to a Facility, i.e. sources concentrated in the same geographic area, using the same administrative information (address, reporting, and other information).

**Codes:** codes are used to categorize sources in EDB. These can be geographic codes or activity codes.

**Alob:** can contain any amount of text. It is used to store data that is impossible to store in the other fields of the point source. If the text in an Alob is in tag = value format, these can be used as search criteria.

### 3.2.2. Emission Specification for Point and Area Sources

The emission levels for point and area sources may be given in two principally different ways:

- Specifying a yearly average (in tons/year, or other unit preferred by the user) of a substance or a substance group. All variations during a year will be normalised in order to always give the same yearly average, no matter the distribution over months, day types and hours. Also temperature emissions will be normalised. This method can also be used to specify the yearly amount of fuel used.

It is also possible specify an emission for a substance as a function of a number of time series using an Indico Presentation macro. The macro must be previously defined in Indico Presentation. The unit of the resulting time series from the macro must be g/s.

- Specifying a maximum effect (in MW) as a consequence of a fuel combustion process. The fuel is defined with a certain energy content, yielding emissions of different substances specified as weight percentage of the fuel itself, or as an emission per energy unit (g/MJ). No normalisation of the variation tables is performed, but the instantaneous emission has an upper limit of 100% of the maximum effect specified for the particular source. See Appendix E2 "Formulae Used for Time and Temperature Dependent Calculations in the EDB" for more details.

### 3.2.3. Emission Specification for Road Sources

The road sources are used to describe traffic emissions, consequently traffic intensity will be the quantitative measure for each individual road source (the unit chosen is the yearly average of the number of vehicles per day). The speed of the vehicles on a road must also be specified. All roads must be linked to a road type, which consists of tables describing the composition of different vehicles frequenting a particular road, and also the time

variation of the traffic intensity throughout the year and over the day. All time variations are normalised in order to ensure that the yearly average traffic intensity is as specified. See Appendix E2 "Formulae Used for Time and Temperature Dependent Calculations in the EDB" for more details. The road type refers up to ten different vehicles. The vehicles contains emission factor for different substances and speeds. Using the speed of the road the correct emission factor can be chosen.

An alternative way of describing the traffic is using complex vehicles. The complex vehicles were developed for usage with the ARTEMIS emission factors. The emission factors in ARTEMIS are not only dependent on the type of vehicles and speed but can depend on up to 11 different factors such as type of road, traffic situation, slope, sinuosity etc. When using complex vehicles the factors and the possible values for the factors are specified. Then the emission factors are specified for all possible combination of the factors for each vehicle. Instead of having a table with emission factors for speeds we will have a multi dimensional cube where the number of dimensions is the same as the number of factors. The vehicles on a road is referred to directly from the road and the percentage of each vehicle on that road is specified as well as time variations. The value of the factors are specified directly on the road.

Congested traffic situations are dealt with by specifying a congested threshold on the link. If the threshold is passed for any hour of the emission simulation, the simulation will use an alternative congested speed when calculating the emission for that link and hour.

### 3.2.4. Output from the EDB

Data from the EDB is obtained by searching for a particular substance under restrictions, which can be combinations of choices of the following:

- all or part of the source name and information strings
- fuels
- substance groups
- formulae
- road type
- vehicle type
- search keys
- map area
- parts of the day or year
- day type
- temperature variation
- codes and ALOB

See Appendix C3 "The Emission Database and Associated Databases" and B4 "Data Import and Export from the Emission Database" for more details.

**Normal output:** Typically the sources found by searching in the EDB are displayed on the map together with the emission figure for each source. The total emission figure is then presented in g/s (or other predefined unit). The result can be zoomed.

**Grid output:** Output can also be presented on the map as a coloured grid. Interval limits can be defined by the user and a different colour assigned to each interval. The map is split up into grid squares - the size of these being chosen by the user - and then the total emission within each square is calculated. Each grid square is then coloured according to which interval the emission figure falls into. The result can be zoomed.

The colour legend showing the grid intervals and colours can optionally be displayed beside the map.

**EDB reports:** Information can be extracted from the EDB and presented as a written description displayed in a separate window, stored as a file or sent to the printer. The user can display selected static data such as source locations, or dynamic information such as the levels of emissions in a specific area for particular time and temperature conditions. Reports can also be used to extract information from the emission database, saving it in files that can be exported to other computer systems. Special formats may be selected in order to facilitate emission data export, for example as emission matrices for GIS systems or for modelling purposes outside the Airviro environment.

Reports of the contents of the Fuel&Substance group, Formula, Substance, Searchkey, Vehicle and Road type databases can also be made, either to a separate window or to the printer.

Some of the report formats can be exported as shape files which enables them to be imported to GIS programs such as ESRI Arcview.

### 3.2.5. Search Conditions

All emission sources in the Airviro EDB can be classified using five groups of search keys. In the first two groups there are 128 individual search keys and in the last three there are 32 in each group. Search keys can be user-defined, and are useful when grouping and combining sources for simulation of emission from different types of sources.

The **Search strings (Name, Info1 and Info2)** that can be given for all sources can be extremely valuable as a complement to search keys. The first string (**Name**) is a string where you should include the name of the source. But in addition you are free to fill the whole string with characters and numbers that can be valuable to classify the source in a convenient way. As an example you can provide a national identification code, property code, etc. If you provide unique characters as separators between the information, it will be easy to use matching facilities when searching for emissions in subsets of the database. The two extra strings **Info1** and **Info2** can be used in the same way as **Name**.

Search conditions and output settings can be stored in a EDB macro. This macro can later be loaded and the emission simulation can be remade with the same type of output.

### 3.3. Grid Layers

For systems with many sources it may be advantageous to group smaller sources and background levels onto a grid.

**Grid layers** are used to describe background emission levels or to generalise many small emission sources. Several grid layers can be defined. A grid layer consists of some common information and information that is different for different grid boxes. An emission is described in the same way as for area sources except that fuel definitions cannot be used. The only way to input a new grid layer is via the ASCII interface but common data for a grid layer can be edited via the EDB user interface. An emission from a grid layer is assumed to be evenly distributed over a grid cell at a height of 2 m above the ground.

Shape file grids can be imported directly to the EDB.

### 3.4. The Temperature Database

As an option a temperature database can be added to use in conjunction with search conditions. When searching, a temperature frequency will be automatically calculated based on the chosen time restrictions. See appendix C3.9 “The Temperature Database” for more details.

### 3.5. Time Series Emissions

It is possible to define sources that use function of Indico time series to define the emission. The user specifies the emission for a substance as a Indico Presentation macro. This macro must be previously defined in Indico Presentation.

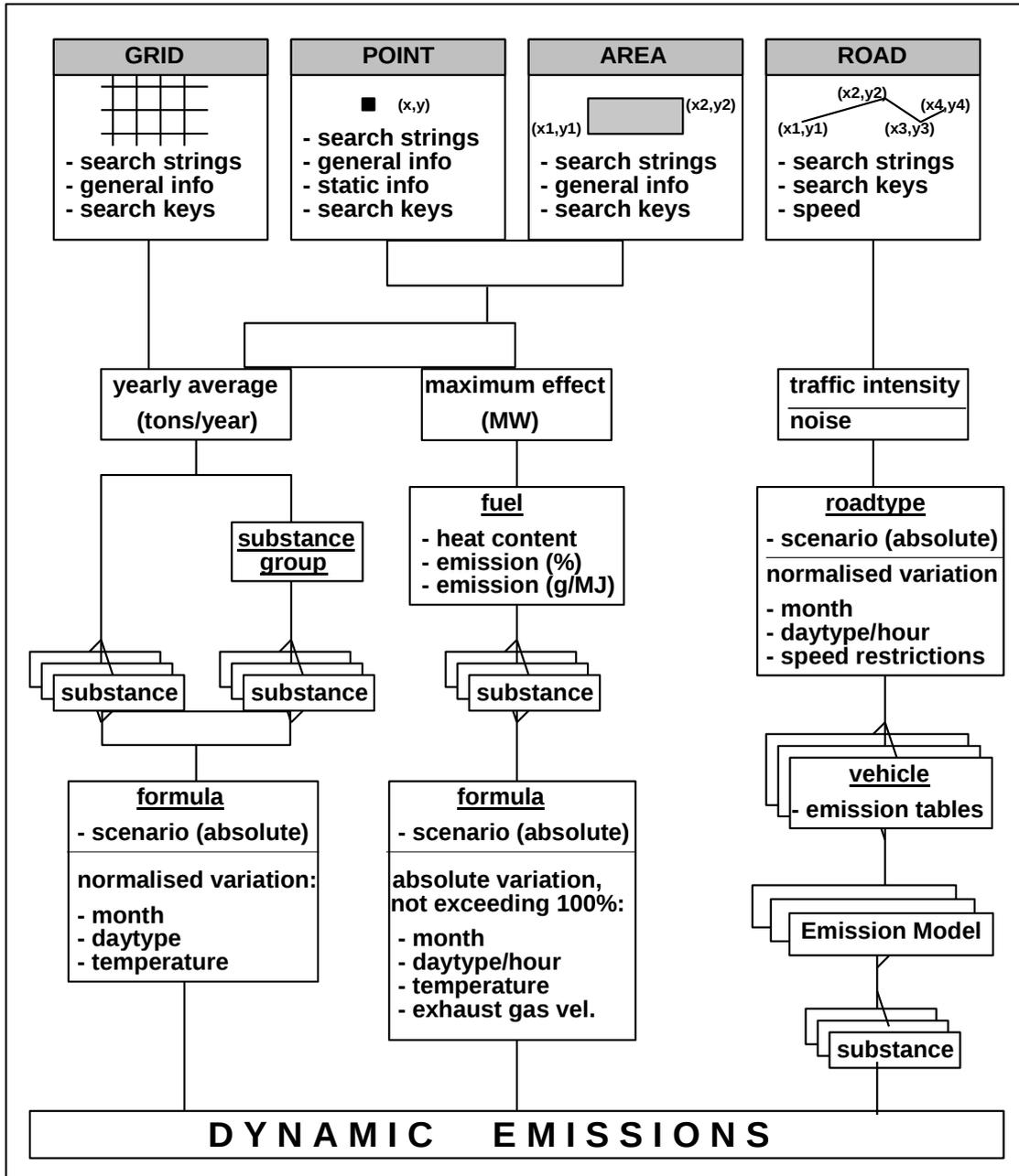


Figure 2: Data Flow in an EDB

## 4. Dispersion

### 4.1. Introduction

The Airviro dispersion models use meteorological data and emission distributions as input to the simulations. Ambient air monitoring data can be used for comparison and validation purposes.

In Airviro 3.0 the settings of the user interface can be stored in a macro in a similar way as in Indico presentation.

Result grids can be presented as text or imported directly to Excel.

Shape grids can be imported as results.

Airviro result grids can be exported as shape grids.

Receptor points can be defined and concentrations from the points viewed.

The grid resolution can be individually set for each dispersion calculation.

The model postprocessor has been integrated into the Dispersion user interface.

There are nine models within the system:

Model	Characteristics
Street Canyon	<ul style="list-style-type: none"> <li>simulates dispersion within vertical cross section in a street canyon</li> <li>the buildings surrounding the street should be equal in height</li> <li>the width of the street should not be larger than 2-3 times the height of the surrounding buildings</li> </ul>
Gauss (Lagrangean)	<ul style="list-style-type: none"> <li>simulates horizontal distributions of pollutants at ground level or - in urban areas - at roof level</li> <li>the simulation area should be relatively flat and with horizontal scales below 20x20 km</li> </ul>
Grid (Eulerian)	<ul style="list-style-type: none"> <li>simulates horizontal distributions of pollutants at ground level or - in urban areas - at roof level</li> <li>allows dispersion calculation in complex topography and over large areas</li> </ul>
Heavy Gas	<ul style="list-style-type: none"> <li>simulates horizontal distributions of heavy gases at ground level or - in urban areas - at roof level as a function of time</li> <li>simulates leakage from pipes or tank bursts</li> </ul>

OSPM (Street Canyon, SMHI Open Road Model)	<ul style="list-style-type: none"> <li>• OSPM street canyon model allows you to perform small scale simulations of the situation at a particular street segment surrounded by buildings. Open Road model is applied in open streets without building.</li> </ul>
US EPA ISC Aermom	<ul style="list-style-type: none"> <li>• Is the newest of EPA's industrial source models</li> <li>• simulates horizontal and vertical distribution of pollutants for Point, Area and Line sources.</li> </ul>
US EPA Calpuf/Calmet	<p><u>Calmet</u></p> <ul style="list-style-type: none"> <li>• It is a diagnostic meteorological model in 3D that also can accept pre-processed wind fields.</li> </ul> <p><u>Calpuff</u></p> <ul style="list-style-type: none"> <li>• Provides a complete spatial variation of wind and stability, hour by hour. It is applicable at distances under 300 km.</li> </ul>
Austal 2000	<ul style="list-style-type: none"> <li>• Austal 2000 from the Environment German Federal Agency is an air dispersion model that uses Lagrangian particle tracking and contains its own diagnostic wind field model. It also considers the influence of topography on the wind field.</li> </ul>
Match (Eulerian)	<ul style="list-style-type: none"> <li>• simulates horizontal and vertical distribution of atmospheric pollutants</li> <li>• includes species-dependent wet and dry deposition</li> <li>• various chemical conversion mechanisms available</li> <li>• uses three-dimensional wind fields generated by an external meteorological pre-processor</li> <li>• suitable for regional applications (5-50 km resolution)</li> </ul>

All models except Match use wind fields originating from the built-in diagnostic wind model (see Appendix E3.1 "The Wind Model - Calculation of the Wind Fields"). The meteorological data and the topographic/physiographic data necessary for the wind field simulation are listed in the following sections and are described in more detail in Appendix D3 "Data Required to setup a System for Dispersion Calculations". Emissions may be specified by the user or taken from the emission database.

Match uses wind and other meteorological data from an external meteorological pre-processor. The meteorological pre-processor can be an analysis system, which enables detailed mapping and investigation of past situations, or it can be a numerical weather forecast model. The latter option is suited for detailed forecasts of the pollution situation in an area. The user is requested to specify what type of data the MATCH model should be shipped with.

The diagram in *Figure 4* shows the basic structure of the different parts of the dispersion calculation process. All models are operated through the main Dispersion window, described in section 4.2 "Basic Functions".

The functionality of the individual models as well as the data flow within each model is given in separate sections, but first some general comments are made.

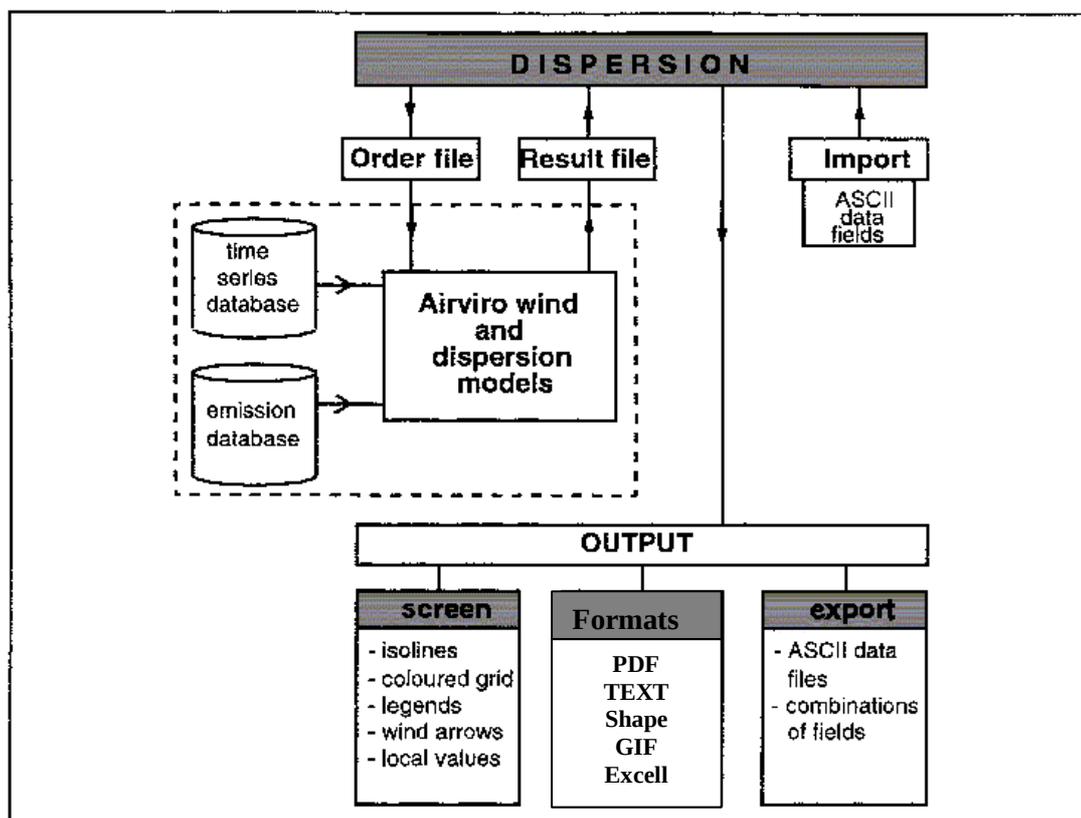


Figure 4: Overview of the Dispersion module

There are three principal steps in a Street Canyon, Gauss or Grid model calculation, the procedure depending on which of the four simulation types Case, Specific hour, Time Period or Scenario that has been chosen:

- |    |  |   |
|----|--|---|
| 1. | Wind field calculation   | Not for the Case type simulations         |
| 2. | Dispersion calculation of an hourly event  |   |
| 3. | Repeated simulation, resulting in consecutive wind/concentration fields                            | Only for <i>Time period</i> simulations   |
| 4. | Repeated simulation and weight averaging yielding an average and five extreme concentration fields | Only for <i>Scenario</i> type simulations |

The wind field calculation and the scenario evaluation are the same for all models (except Match), and these functions are briefly described in sections 4.1.1 "Wind Field Calculation" and 4.1.2 "Scenario Calculations". In section 4.1.3 "Links Between Dispersion Models and Emission Database (EDB)" the link between the dispersion models and the emission database (EDB) is described.

#### 4.1.1. Wind Field Calculation

The horizontal wind field calculation is based on hourly data from at least one meteorological station in the locality of the simulation domain. The parameter configuration of the meteorological stations should be as follows:

- Principal masts: Monitoring of wind speed and direction at one or two levels, vertical wind speed, absolute temperature and vertical temperature difference. From these measurements standard deviations of horizontal wind direction and vertical wind speed should also be evaluated.
- If available, the wind model may additionally use information from more traditional meteorological stations.
- Complementary stations: Monitoring of wind speed and direction at one level plus temperature.

The meteorological stations and parameters to be used as input to the wind model, as well as their influence area, are defined in a resource file forming part of the installation configuration. For more information see Appendix C5 "The Topography and Physiography Database".

The meteorological data are used to calculate the stability regime of the surface boundary layer (scaling parameters, see Appendix E3.1.4 "Stability and Turbulence Estimation - Pre-processing of Meteorological Data" for details). The measured data is used to estimate the free wind over the area, i.e. the wind at a level that is unaffected by the surface. The actual wind model calculation consists of an interpretation of the surface winds resulting from local adaptations to local fluxes of heat and momentum (see Appendix E3.1 "The Wind Model - Calculation of the Wind Fields" for more details). The following surface information must be known and evaluated over a grid:

- topography
- land use (distinguishing between, as a minimum, urban areas, forested areas, open fields and water)
- typical heights of buildings in urban areas

The Gauss and Grid dispersion models do not resolve individual buildings. Instead, surface structures like houses and trees enter the model through the roughness values per grid cell and, as a consequence, through the wind field.

For a detailed specification of the requirements on the data needed for the wind model implementation, see Appendix D3.4 "Necessary Weather Information for Airviro".

The Grid model produces time dependent results that take earlier conditions into account.

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**Note:** If meteorological mast data (as specified for the principal mast) is not available then the Street Canyon and Gauss model can only be used with the Case option, that is without running the dynamic wind model. The Grid model can only be used with meteorological mast data.

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#### **4.1.1.1 Wind fields for Match**

For Match, the wind field is generated by an external meteorological pre-processor. Match always uses meteorological field data in FM92 GRIB format. Data must be stored for a configured map area with a defined resolution. Data must reside on disk for the time period under investigation.

#### **4.1.2. Scenario Calculations**

The aim of the scenario calculation is to make it possible to simulate long term impacts of emission scenarios, without running through a very long time period, hour per hour. In order to achieve a climatology that reflects the local variations of weather conditions, more than one, and preferably five years of monitoring data from a meteorological mast is necessary.

An Airviro installation usually involves the creation of a few scenarios, to be defined according to national standards. As default, the scenario list will contain two seasons to be defined according to the application area.

For both the Gauss and the Grid model, the user selects a particular scenario from a list of prefabricated statistical climatologies (see Appendix D3.4.10 "Climatology Data for Long Term Scenario Calculations"). A scenario consists of a number of historic events given as specific dates and times, representing a class of meteorologically similar events, together with the frequency of occurrence of the classes. Hourly simulations are performed for class representatives which are weighted with their frequency of occurrence, summed up and presented as an average concentration field plus the 95th, 96th, 97th, 98th and 99th percentiles of the scenario period.

Scenario calculations are not possible to use with the Match model.

#### **4.1.3. Links between Dispersion Models and Emission Database (EDB)**

The dynamic emission database has been described in section 3. "Emission Database (EDB) for Ambient Air Emissions". Search criteria available in the EDB module may also be used to describe the emissions feeding a dispersion calculation. Note however that day type, hour and temperature will be defined by the date of the meteorological data.

Point sources will be treated individually in the dispersion calculation, that is first passing a plume rise calculation and subsequently taken into the dispersion calculation. Area and road sources defined in the EDB will firstly be collected on a surface grid (2 metre level), where all emissions within an individual grid will be emitted from a point located in the grid centre.

## 4.2. Basic Functions

The Dispersion module provides the user with menus for ordering batch execution of dispersion calculations and for examining and analysing the results of dispersion calculations. The user first chooses the simulation model to use. This can be one of four that have currently been developed - the Gauss model, Grid model, Street Canyon model or Heavy Gas model. The Dispersion module is also prepared to be able to use external models. The following functions are common to all Airviro Dispersion models.

**Model Settings** The model settings, type of simulation and weather conditions to be used as a basis for dispersion calculations can be specified. The choices available depend on the model that is used and are listed for each model in sections 4.3 "Street Canyon Model" to 4.6 "Heavy Gas Model".

**Emissions** Specification of the emission sources to be taken into account for dispersion calculations. The supported source types depend upon the model being used and are listed for each model in sections 4.3 "Street Canyon Model" to 4.6 "Heavy Gas Model".

**Map** The user can choose amongst available maps, and can zoom in/out to sub-areas on maps shown.

**Calculate** The user can specify a title for the calculation and edit the calculation height (for Gauss and Grid model). The calculation is then started as a batch job.

**Results** Calculation results are sorted according to user, project and simulation type. The user can browse through titles of calculation results and select one for viewing or further processing.

**Output Settings** The user can choose between grid or isoline output, change isoline distance or grid limits and colours. It is also possible to select various display options such as showing the resolution of the dispersion calculation, showing the colour legend (for grid output) and including a description of the displayed dispersion patterns.

### Advanced Settings

The user can apply arithmetic expressions (all the formulae described in Appendix E4 "Calculation Formulae" may be used), smoothing filter, set the background level and set a running average for time series of fields.

**Viewer** The viewer allows the user to browse the different fields of a result and also to step forth and back in a time series of fields. The fields are shown according to the Output Settings made. Local concentration values can be displayed on the map using the mouse. As an option the wind field can also be shown together with the dispersion pattern.

**Snapshot** The user can show the calculation results at present shown in the dispersion viewer window. A snapshot is made, copying the currently viewed result to a new static window which can then be used for comparison or cut/paste to other applications. Several output formats are

available (see Appendix B6 "Import and Export of Fields in the Dispersion Module" for a format description).

Watch	Allows the user to monitor ongoing dispersion simulation runs.
Postprocessor	The user can do further processing on dispersion results. See "4.10 Postprocessing results from Dispersion" below.
Import	External dispersion fields can be imported to the Dispersion module. ASCII format or Shape is currently supported (see Appendix B6 "Import and Export of Fields in the Dispersion Module" for a format description).
Nesting	Nesting admits a calculation in a smaller area (local) to use the background concentrations from a larger area (urban) without double calculating the emissions in the smaller (local) area. This can be done in any number of nesting steps.
Parallelization	The time series simulation will be split up into several parts that can run in parallel and the result will be joined together and give the same result as if the run was not split.
Macros	Allows the user to load, save and delete the results and all the steps to make a simulation

### 4.3. Street Canyon Model

The Street Canyon model allows the user to perform small-scale simulations of the air quality conditions for a particular street surrounded by buildings of about the same height. The model output is presented as concentration isolines on a vertical plane perpendicular to the street (for more details see Appendix E3.4 "The Street Canyon Model").

The model is operated through the Dispersion main window and has the following features.

#### **Model Settings:**

There are four possible ways of specifying the meteorological conditions:

1. Case  
The user specifies the wind direction (in degrees), wind velocity (m/s) and selects one of several stability regimes (labile, neutral, etc.). No wind model calculations are performed, instead the meteorological conditions will be horizontally uniform. The dispersion coefficients are configured as part of the installation procedure (see Appendix D4.4 "Dispersion Characteristics for the Case Calculations within the Gauss and Street Canyon Models").
2. Specific hour  
The user selects a historic date and hour for which the corresponding meteorological data is fetched from the time series database. The measured data is used as input to the wind model, and the roof level wind at the street canyon position is evaluated from the calculated wind field.

### 3. Time Period

The user specifies start and stop time. The model will be executed for all hourly events within the specified time period, if meteorological data exist.

### 4. Scenario

The user selects a particular scenario from a list of precalculated statistical climatologies. A scenario consists of a number of historic events, representing a class of meteorologically similar events together with the frequency of occurrence of the classes. All class representatives are evaluated and weighted with their frequency of occurrence, summed up and presented as a mean and as 95th, 96th, 97th, 98th and 99th percentiles for the scenario period. A typical scenario is for example a winter season.

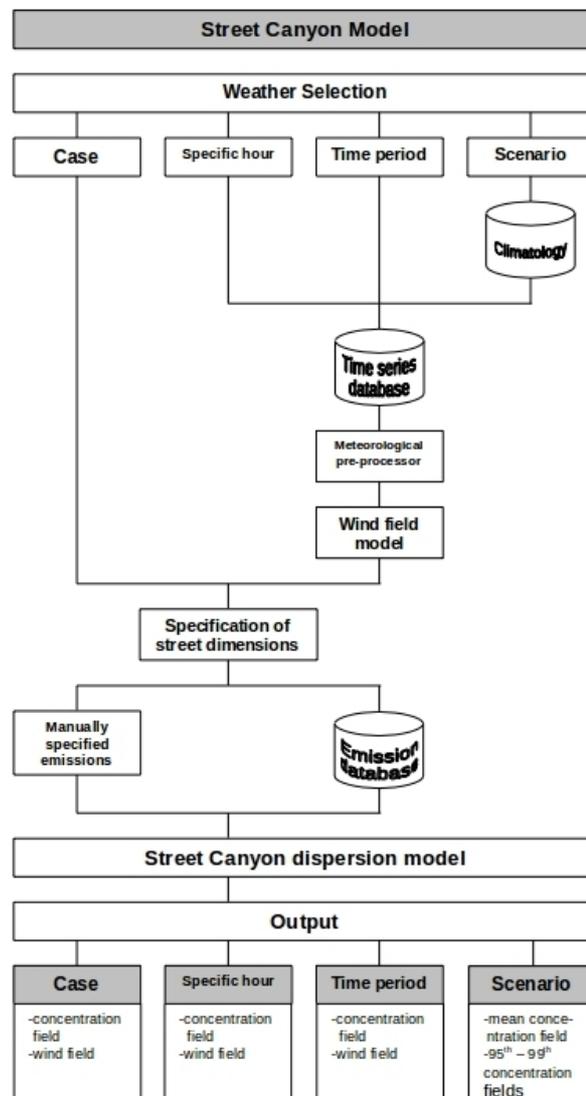


Figure 5: Data flow for the Street canyon model

**Emissions** Emission is specified for the street canyon. The following information is entered:

- substance to be dispersed
- position of street (to be marked on the digital map using the mouse pointer)
- distance between houses
- height of the houses surrounding the street
- width of the street
- principal direction of the street
- emission from the street, either given explicitly (in mg/m,s) or calculated from a road type defined in an emission database (the user specifies the traffic intensity and speed).

The general functions and options listed in section 4.2 "Basic Functions" are all available for the Street Canyon model.

#### **4.4. Gauss Model**

The Gauss model is used to simulate the distribution of ground concentrations of pollutants over urban or industrial areas where the topography is relatively flat, and where the horizontal dimensions are not too large (the upper limit is approximately 20x20 km). The simulation results represent hourly mean values.

The ground concentration level is by default defined as being 2 m above the ground in rural areas, but at roof level in urban areas. The simulation of roof level concentrations has been achieved by calculating an initial vertical diffusion that depends on the typical building height (see Appendix E3.2 "The Gauss Model").

The Gauss model is operated through the Dispersion module, with the following options:

##### **Model Settings**

There are five possible simulation types:

1. Case

The same as for the Street Canyon model (see section 4.3 "Street Canyon Model")

2. Case with Edb

This selection allows the user to run case using an emission database.

3. Specific hour

The user specifies a date and hour for which the meteorological data is fetched from the time series database. This data is used as input to the wind model, the emission simulation (if EDB source is used) and also - for the plume rise and plume growth calculation - to the dispersion model itself.

#### 4. Time Period

The user specifies the start and stop time. The model will be executed for all hourly events within the specified time period, and for the meteorological data that exist.

#### 5. Scenario

The same as for the Street Canyon model (section 4.3 "Street Canyon Model")

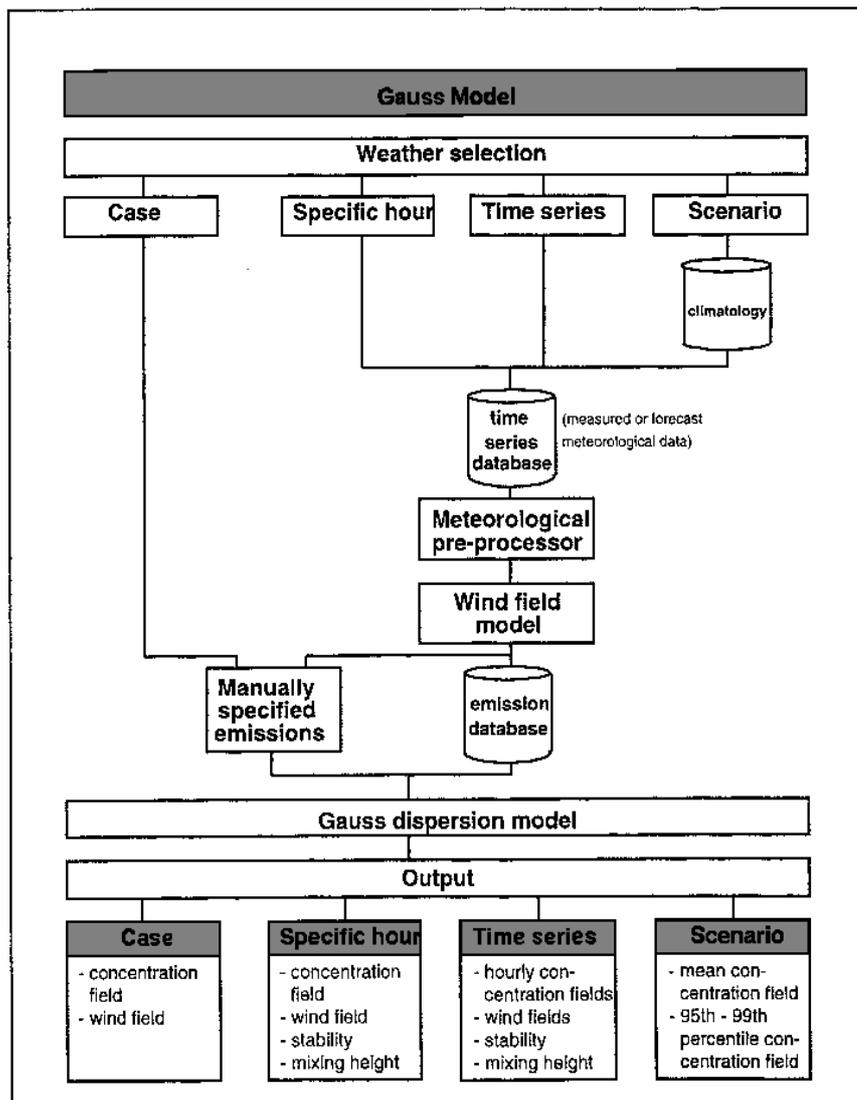


Figure 6: Data flow through the Gauss model

**Emissions** There are four choices on how to specify the emission:

- *Point sources*

For one or several sources, the user should specify the following emission characteristics as input to the plume rise calculation:

- substance to be dispersed
- location of source
- emission expressed in g/s
- information relevant for the plume rise calculation:
  - stack height, inner and outer diameter
  - temperature and velocity of exhaust gases at stack outlet
  - typical height and width of surrounding buildings

- *Area sources*

For one or several sources, the user should specify:

- substance to be dispersed
- location of source (a rectangle)
- expected plume height
- emission expressed in g/s

- *Road sources*

For one or several sources, the user should specify:

- road source location, built up by a number of straight links
- emission rates for every link, expressed in mg/m,s

- *EDB sources*

If *Specific hour* or *Scenario* has been chosen as a meteorological condition, it will be possible to connect a global or personal EDB to be used for dispersion calculation. Day type, hour of the day and temperature will be defined by the actual date specified in the **Weather** subwindow. All other search criteria available may be specified by the user (see EDB functionality in section 3. "Emission Database (EDB) for Ambient Air Emissions").

**Calculate** In addition to the general functionality described in section 4.2 "Basic Functions", the user can define the calculation height (above ground or - in urban areas - above roof level).

Refer to Section 4.2 "Basic Functions" for other general functions available in the presentation of Gauss model simulations.

## 4.5. Grid Model

The Grid model is used to simulate the distribution of ground concentrations of pollutants over areas where the topography is complex, and/or where the horizontal dimensions are large. The model solves the transport equations over a terrain-following, three-dimensional calculation grid. The simulation results represent hourly mean values. The output produced by the model is configured in a resource file as part of the installation procedure, and consists by default of:

- concentration fields at ground level (or at roof level over urban areas)
- surface wind components (10 m level)

In order to handle point source emissions in a proper way, a model hybrid approach is used: The point source dispersion process is initially modelled as a Gaussian puff following a trajectory in the wind field. The point source emissions will be incorporated in the grid calculation as soon as the puff has reached a magnitude comparable with the horizontal grid size (see Appendix E3.3 "The Grid Model").

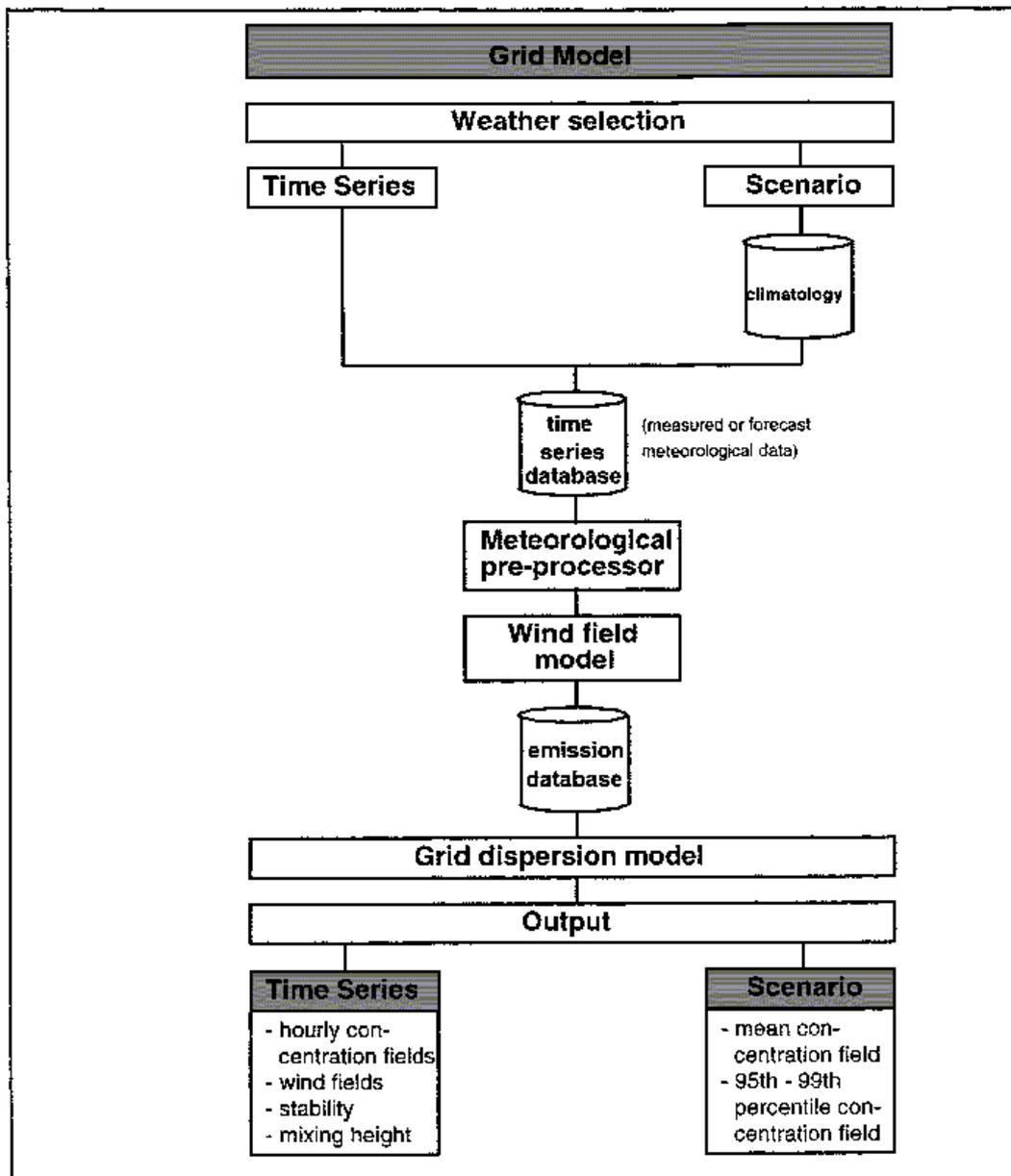


Figure 7: Data flow through the Grid model

The Grid model is operated through the Dispersion main window, with the following options.

### Model Settings

There are three possible simulation types:

1. Time period

The user specifies the start and stop time. The meteorological data for this period should be available in the time series database, and they will be used as input to the wind model, the emission simulation and also - for the plume rise and Gauss puff growth calculation - within the dispersion model itself.

2. Scenario

The same as for the Gauss/Street Canyon models

3. Forecast  
Enables the possibility to do time period runs in the near future using meteorological forecast data from a virtual mast to produce a deterministic forecast.

**Emissions** The emissions in a grid model simulation must be taken from an EDB.

#### EDB sources

Day type, hour of the day and temperature will be defined by the actual dates specified in the "Model Settings" window. All other search criteria available may be specified by the user (see EDB functionality in section 3. "Emission Database (EDB) for Ambient Air Emissions")

Refer to Section 4.2 "Basic Functions" for other general functions available in the presentation of Grid model simulations.

## 4.6. Heavy Gas Model

The Heavy Gas model is used to simulate the leakage of liquids or heavy gases (gases that are heavier/denser than air) from a pipe or tank. Both continuous leakage and tank bursts can be simulated. A set of simulation results is obtained, where each result is for a predefined number of minutes after the leakage began.

The following substances are supported in the standard model:

- Ammonia
- Chlorine
- SO<sub>2</sub>
- Propane
- Vinyl Chlorine
- Methane

The result output consists of:

- concentration fields at ground level (or at roof level over urban areas)
- surface wind components for the start time (10 m level)
- calculated mixing height and Monin-Obukhov length

The Heavy Gas model is operated through the Dispersion main window, with the following options.

**Model Settings** There are two possible simulation types:

1. Specific hour

The user specifies the stop time. The meteorological data for the chosen hour should be available in the time series database, and they will be used as input to the wind model and the emission simulation.

2. Case

The same as for the Gauss/Street Canyon models

**Emissions** The emission in a Heavy Gas model simulation is defined by the following parameters: Pipe length and diameter can be specified, as well as tank contents. A choice of substances is available and the properties of these substances must be predefined in a resource file.

Refer to Section 4.2 "Basic Functions" for other general functions available in the presentation of Heavy Gas model simulations.

#### **4.7. OSPM (Street Canyon, SMHI Open Road Model)**

The OSPM street canyon model allows the user to perform small-scale simulations of the air quality conditions for a particular street segment surrounded by buildings.

However, the SMHI Open Road model is applied in open streets without buildings. The heights of buildings are defined in EDB module as properties of the road (Roads - Height)

The OSPM model is operated through the Dispersion main windows and has the following features.

##### **Model Settings**

There is one possible simulation type:

1. Time period

The user specifies the start and stop time. The meteorological data for this period should be available in the time series database, and they will be used as input to the wind model, the emission simulation and also - for the plume rise and Gauss puff growth calculation - within the dispersion model itself.

**Emissions** The emission in an OSPM model simulation is defined by the following parameters: receptor height, distance from the road to the receptor and substances. However, the SMHI Open Road model is applied in open streets without buildings.

Refer to Section 4.2 "Basic Functions" for other general functions available in the presentation of OSPM model simulations. For this model, the grid is only used by the Danard Wind model to give the wind data for each street.

## 4.8. US EPA Aermod

US EPA Aermod is an advanced plume model that incorporates updated treatments of the boundary layer theory, understanding of turbulence and dispersion, and includes handling of terrain interactions. The model was formally proposed by US EPA in 2000 as a replacement for the ISCST3 model.

The US EPA Aermod model is operated through the Dispersion main window, with the following options.

### **Model Settings**

There is one possible simulation type:

1. Time period

The user specifies the start and stop time. The meteorological data for this period should be available in the time series database, and they will be used as input to the wind model, the emission simulation and also - for the plume rise and Gauss puff growth calculation - within the dispersion model itself.

**Emissions** The emissions in a grid model simulation must be taken from an EDB.

#### EDB sources

Day type, hour of the day and temperature will be defined by the actual dates specified in the "Model Settings" window. All other search criteria available may be specified by the user (see EDB functionality in section 3. "Emission Database (EDB) for Ambient Air Emissions")

Refer to Section 4.2 "Basic Functions" for other general functions available in the presentation of model simulations.

## 4.9. US EPA Calpuf/Calmet

Represents the state in Lagrangian puff modeling for assessing impacts of the long-range transport of certain pollutants. The Calmet/Calpuff modeling system can simulate atmospheric dispersion on transport scales of from tens of meters to tens of kilometers and from tens of kilometers to hundreds of kilometers.

The US EPA Calmet/Calpuff model is operated through the Dispersion main window, with the following options.

### **Model Settings**

There is one possible simulation type:

1. Time period

The user specifies the start and stop time. The meteorological data for this period should be available in the time series database, and they will be used as input to the wind model, the emission simulation and also - for the plume rise and Gauss puff growth calculation - within the dispersion model itself.

**Emissions** The emissions in a grid model simulation must be taken from an EDB.

#### EDB sources

Day type, hour of the day and temperature will be defined by the actual dates specified in the "Model Settings" window. All other search criteria available may be specified by the user (see EDB functionality in section 3. "Emission Database (EDB) for Ambient Air Emissions")

Refer to Section 4.2 "Basic Functions" for other general functions available in the presentation of Calpuf/Calmet 2000 model simulations.

## **4.10. Austal 2000**

Austal 2000 from the Environment German Federal Agency . It simulates the dispersion of air pollutants. This dispersion model that uses Lagrangian particle tracking and contains its own diagnostic wind field model. It also considers the influence of topography on the wind field, and resuspension.

The Austal 2000 model is operated through the Dispersion main window, with the following options.

### **Model Settings**

There is one possible simulation type:

1. Time period

The user specifies the start and stop time. The meteorological data for this period should be available in the time series database, and they will be used

as input to the wind model, the emission simulation and also - for the plume rise and Gauss puff growth calculation - within the dispersion model itself.

**Emissions** The emissions in a grid model simulation must be taken from an EDB.

#### EDB sources

Day type, hour of the day and temperature will be defined by the actual dates specified in the "Model Settings" window. All other search criteria available may be specified by the user (see EDB functionality in section 3. "Emission Database (EDB) for Ambient Air Emissions")

Refer to Section 4.2 "Basic Functions" for other general functions available in the presentation of Austal 2000 model simulations.

### 4.11. MATCH model

MATCH is an Eulerian three-dimensional transport and chemical conversion model. It is used to calculate the three-dimensional atmospheric concentration field and the surface deposition of various chemical species. Any species that is included in the emissions database can be simulated with or without dry- and wet- deposition. The user may specify the rate of dry deposition to various surfaces and may also specify the effectiveness of the wet scavenging in a resource file.

The MATCH model also includes various chemical conversion modules that are aimed at simulating a certain group of chemical compounds. The different applications are selected by the user in the graphical interface by choosing between different MATCH models. The currently implemented MATCH versions are summarised in the table below.

Model	Characteristics
MATCH model 1 (M1)	Inert tracer without deposition
MATCH model 1 (M2)	Inert tracer with species dependent dry and wet deposition
MATCH model 1 (M3)	Sulphur chemistry. SO <sub>2</sub> and sulphate simulated. Wet and dry deposition included.
MATCH model 1 (M4)	Coupled sulphur and nitrogen chemistry. Simulates SO <sub>2</sub> , sulphate, oxidized and reduced nitrogen (9 chemical species).
MATCH model 1 (M5)	PAH chemistry

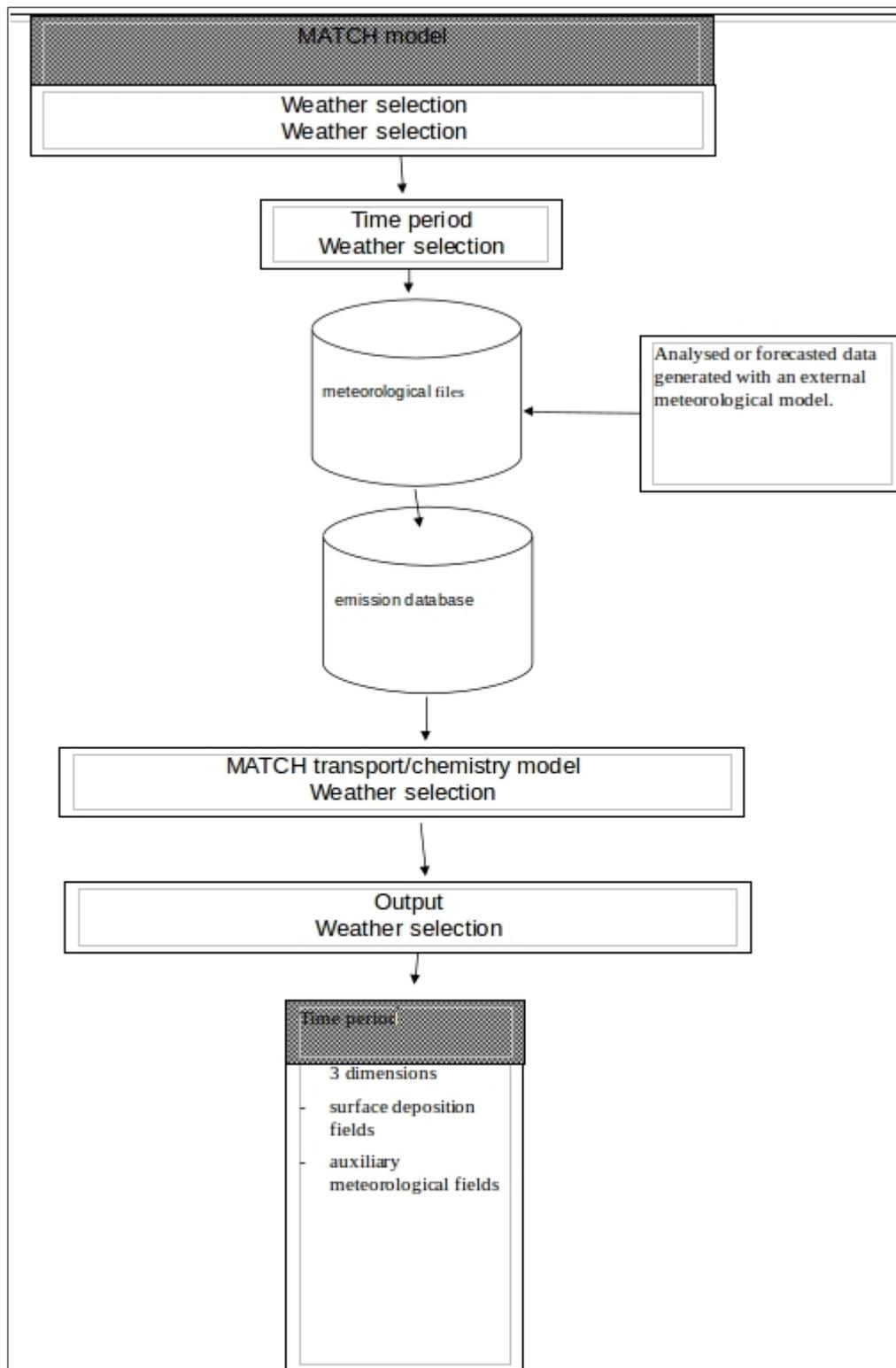


Figure 8: Data flow through the MATCH model

The Match model is operated through the Dispersion main window, with the following options.

**Model Settings**

In MATCH it is only possible to simulate time periods. The user specifies

start and stop time in the graphical user interface. It is necessary to ensure that meteorological data is available for the time period and domain under consideration.

**Emissions** Emissions are extracted from the EDB. MATCH distinguishes between area ( “Area”, “Road”, and “Grid”) sources and point sources. In order to correctly simulate the atmospheric concentration of a species - also close to a large point source - these emissions are treated in a separate Lagrangian model before being incorporated in the Eulerian model. The smaller point sources are treated as vertically resolved area sources. For M1 and M2 it is possible to choose any species in the selected EDB. For the other model versions it is implicitly assumed what species are being emitted. M3 needs SO<sub>2</sub> emissions; M4 needs SO<sub>2</sub>, NO<sub>x</sub>, and NH<sub>3</sub> emissions. It is always possible to impose restrictions or only include certain source types during a simulation.

**Results** The results are given as horizontal fields of atmospheric concentrations and surface depositions every hour. It is possible to view the concentration in any model level, supported units are molar mixing ratios and mass concentration at ambient temperature and pressure. Additionally, a number of meteorological parameters are also available for display in the graphical interface or statistical treatment. The meteorological parameters include precipitation, cloud cover, boundary layer height, temperature, near-surface winds, *etc.*

## 4.12. Source Location & Emission Estimation Models

These models imply a statistical comparison between measured concentration values in certain locations (receptor points/open paths) and simulated concentrations evaluated at the same locations. Consequently the Receptor model is a mixture of Indico Presentation and the Dispersion module.

Based on high quality concentration and meteorological data, the Receptor module addresses two problems:

- Tracing and location of dominant sources contributing to air pollution
- Emission estimation of dominant sources

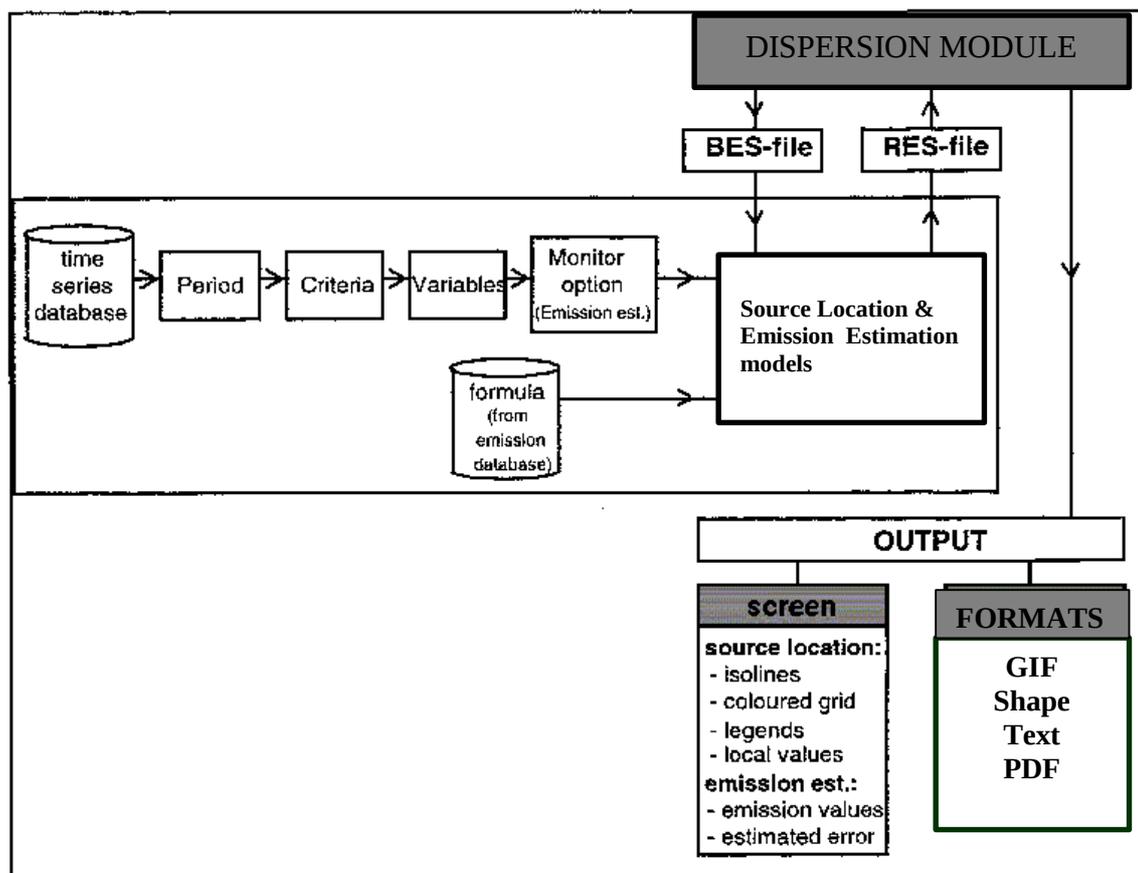


Figure 9: Overview of the Source Location & Emission Estimation models

There are several reasons to recommend a small-scale application of this module:

- the dispersion calculation is Gaussian
- no wind model is used, the wind field is assumed to be horizontally homogeneous
- in urban areas, most sources are only dominant on a smaller scale (traffic is such an example)

In addition, the models are recommended for use with ground level area emission sources (for emission heights up to the height of the meteorological mast that is used) as opposed to high stack emissions.

A description of the calculation procedures can be found in Appendix E5 "Model Descriptions for the Source Location & Emission Estimation models". Weather data should be from a principal mast (the requirements for a mast are described in Appendix D3.4 "Necessary Weather Information for Airviro") within the vicinity of the simulation area. Concentration data must also be of high quality and must be available within the simulation area, preferably from more than one site/open path.

The Source location and Emission estimation models are operated through the Dispersion main window, with the following options.

- Model Settings**      The following data is used as input data.
- Period**              The user specifies the start and stop time for the calculation period, for which the Receptor module will look for meteorological as well as monitored concentration data in the time series database.
- Meteorology**        The user must select a meteorological station and the following parameters:
- wind speed and direction at one or two levels
  - absolute temperature
  - vertical temperature difference
  - standard deviation of horizontal wind direction
  - standard deviation of vertical wind speed
- It is possible to apply mathematical transformations/criteria to this data, if desired.
- Concentrations**     The user selects time series of a monitored pollutant from one or - preferably - several stations. It is possible to apply mathematical transformations/criteria to this data, if desired.
- Results**              For the preliminary source location calculation the output is presented as isolines of the horizontal distribution of the correlation coefficients multiplied by 100.

The isoline pattern can then be used to estimate the size and location of the dominant source(s).

The emission estimation model (which uses the stepwise regression model) is then used to give an estimate of the emission magnitude(s).

If the impact of the sources to be estimated gives a clear signal in the measured concentration data, the method will yield a coefficient that scales the normalised simulation time series. The multiple correlation coefficient is the overall measure of how good the source assumptions are.

For a given number of sources, the source specific standard error (the standard deviation of the estimated error in the emission estimation for a particular source) is the measure of how good a source estimate is. Assuming the estimate error to be normally distributed, it gives the interval of the 67% confidence level (twice times the estimate error gives 95% confidence level).

### **4.13. Source Location Model**

The dominant sources are found by correlating time series of measured and simulated concentration data, the latter originating from an area described by a grid of hypothetical point sources distributed over the calculation domain (see Appendix E5 "Model Descriptions for the Receptor Module").

**Model Settings** The following functions are used in the calculation of dominant sources.

**Emissions** The user has to assume some basic characteristics of the emissions looked for:

- the plume height over which the dominant source emissions are likely to be most concentrated
- the emission variation over day types and over the hours of the day (if not assumed constant, it should be given by a connection to an existing formula in an EDB)

**Results** The output of a Source location calculation consists of a horizontal field of correlation coefficients, where strong maxim reflect areas where dominant sources are expected to be located. The correlation field can be presented as isolines or as a coloured grid pattern.

**Viewer** The user can display local values from the correlation coefficient field on the map area using the mouse.

Refer to Section 4.2 "Basic Functions" for other general functions available in the presentation of Source Location model simulations.

#### **4.14. Emission Estimation Model**

The emission estimation module can calculate emissions from one or various areas of the calculation domain, provided that:

- the emission from a particular source can be described as a rectangular area source
- the emitted pollutant plume from a particular source spreads out at a height that is possible to estimate
- the emission is constant or can be described reasonably by an EDB formula
- the meteorological and monitoring stations are located in a adequate way to catch the impact from the sources analysed
- sources are used that emit close to the ground

The emissions are estimated through a multiple regression analysis between simulated and measured concentration time series (see Appendix E1 "Statistical Models").

**Model Settings** The following functions are used in the emission estimation.

**Emission** The user has to assume some basic characteristics of the sources that are used to estimate the emissions:

- the location of the area source rectangles to be estimated
- the plume height of the emissions coming out from these area sources

- the emission variation over day types and over the hours of the day of the emissions coming out from the same area sources (if not assumed constant, each source should be given a connection to an existing formula in an EDB)

There is also a choice of sorting out the background impact caused by sources not included in the estimation (both those inside and those outside the calculation routine). The two choices are:

- Constant background level (will form part of the multiple regression analysis)
- Monitor option: The background level can vary in time according to a time series constructed from a subset of monitored concentrations values, defined by the criteria that there should be no possibility of impact from the sources (this normally means that the wind direction is such that no impact is possible from the given area sources). See Appendix E5 "Model Descriptions for the Receptor Module" for further details.

### **Calculate**

As for the general case described under section 4.2 "Basic Functions", but the user has to specify statistical parameters for the multiple regression calculation.

### **Results**

The output of an Emission estimation calculation will be presented on the background map as an emission rate (in g/s) followed by the standard error (standard deviation of the estimated error). The background value is given as a constant resulting from the regression analysis. If the Monitor option has been activated, the average value of the time varying background level will be given

Refer to Section 4.2 "Basic Functions" for other general functions available in the presentation of Emission Estimation model simulations.

## **4.15. Post processing results from Dispersion**

After a model run you may use the ordinary tools in Dispersion for presenting the results. However, particularly for Time period and Forecast simulations, there is a special interface for data analysis.

The typical results from the Dispersion module are fields with hourly mean concentrations (except for Scenario, which is a weighed field for many hours). In order to evaluate the results, for example to produce output required for comparisons with different guidelines and standards, it is often necessary to either make a statistical study of the results or to use a diagram presentation for some point in the field.

With the Model Postprocessor, it is possible to make a statistical study or to create new time series, which may be viewed with the Dispersion Module. It is also possible to export the simulated concentrations to the time series database for a station in the calculation grid,

in order to make comparisons between measured and simulated concentrations in a diagram within Indico Presentation.

The model postprocessor is operated through the Airviro main window and has the following features.

**ACTION** There are five different methods available for post processing:

- Spatial Evaluation

Calculates descriptive statistics, frequency statistics and exceedance statistics of a model time period. Running averages and peak-to-mean correction factors may be applied to compensate for different averaging times. Constraints on data capture can be set to ensure quality standards. Results are stored as simulation type Combined.

- Time series export

Exports model results to the time series database. This method operates on a specified location in the calculation grid. The exported time series can be monitored with Indico Presentation.

- Model adjustment

Performs a spatial interpolation of model results with available measured data. The method yields a normalised concentration field with emissions from known sources. Results are stored as simulation type Combined.

- Split model result

Creates a new model time period as a contiguous subset of the original model time period. Episodes can be lifted out for further detailed studies. Results are stored as simulation type Time period.

- Merge model results

Creates a new model time period by merging original model results into a longer model time period. A long calculation (i.e. one model year) with many sources can be divided into smaller calculations, even at different computers, and later be merged into a long time period that is evaluated against guideline values. Results are stored as simulation type Time period.

- Combine model results

Combines several dispersion results using arithmetic expressions to create a new result. (all the formulae described in Appendix E4 "Calculation Formulae" may be used). Results can even be combined that have been carried out on different sizes of the background map. The new result will then cover the geographical intersection of all areas in the included results. Combination of time series of fields is also possible. Results are stored as simulation type Combined.

### 4.15.1. Spatial Evaluation

Spatial Evaluation is useful for making comparisons with air quality guidelines or for a general description of some meteorological data that have been used in a calculation.

Spatial Evaluation operates on a scalar variable field, usually a mass concentration field, but it could also be wind speed, mixing layer height or inverse of Monin-Obukhov length or some other scalar field.

Descriptive statistics, such as mean value, min, max, standard deviation and max day mean is always calculated when you operate on hourly values. To allow for missing values, you can specify minimum data capture by clicking the **Percentage...** button. If data capture is below the specified value, averages and running averages will not be calculated.

Frequency statistics can be calculated as **Percentiles** in the interval 90%-100%. A percentile of some variable during a time period, say the yearly 99.9<sup>th</sup> percentile of hourly mass concentration, is the value which 99.9% of the cases fall below. In this case, only eight hours during a year have mass concentrations that exceed that percentile.

The yearly 90<sup>th</sup> percentile of daily mass concentrations can be calculated by first calculating **Daily average** with Spatial Evaluation and save the result with a **Description** like 'PM-average 2002', then running Spatial Evaluation once again and order the 90<sup>th</sup> percentile, which now operates on daily averages.

The half-yearly 98<sup>th</sup> percentile of 8-hourly mass concentrations can be calculated in a similar way by first calculating **8 hours Running averages** and save the result with a name like 'CO-average winter 2001/02'. Run Spatial Evaluation again, now operating on the new 8-hourly running mean values and order the 98<sup>th</sup> percentile.

It is also possible to create frequency statistics for shorter sampling periods by entering **Correction factors** for 15-minute averages. A value of about 1.6 would be appropriate for point sources and about 1.35 for line sources, but a more detailed approach can give better information for all percentiles.

Exceedance statistics can be calculated by specifying a threshold value with **Exceeded limit**. The resulting field shows the percentage of values that exceed the specified limit.

### 4.15.2. Time series export

Time series export is useful when you want to export a model time period to the time series database, e.g. if you want to test input data requirements for the Receptor model, or if you have some scenarios that you want to manually evaluate against measured data.

Time series export operates on any scalar variable field, usually the mass concentration field, but it could also be wind speed, mixing layer height or some other scalar field. Choose your actual **Time series** variable for the selected model result.

The time series database requires that data is stored with station and parameter as reference. Choose **Station** among active stations within the calculation area. If you have to define a new station, see 6.4 *Understanding the Station Database and Setting Up a Station* in *User's Reference Volume 6: Using the Indico Administration Module*.

Next, you must choose a **Parameter** from the parameter database. Choose a parameter that has the prefix 'sim' in the name to avoid confusion with measured parameters. If none of the available parameters is applicable, create a new parameter in Indico Administration. See 6.3 *Viewing and Editing the Parameter Database* in *User's Reference Volume 6: Using the Indico Administration Module*.

### 4.15.3. Model adjustment

Model adjustment is useful if you want to take measurements into consideration when you evaluate your Dispersion calculations. It can be used to estimate the quality of your emission database or to improve the quality of your simulation.

Model adjustment operates on any scalar variable field. Choose **Time series** variable for the selected model result.

The time series database requires that data is stored with station and parameter as reference. The choice of active measuring stations and parameters for comparison with model results should be defined in an Indico macro. Choose a **Macro** in the adjust group that corresponds to your needs.

The adjust macros are located at /usr/airviro/data/ Domain\_name/indico/adjust. Use Indico Presentation to view or edit macros. The adjust macro, with prefix 'health\_' should include all active stations and the parameter that you want to refer to for the actual variable.

You may enter an optional **Factor**, e.g. if you compare modelled data for another species than what was measured, but only if the two species are covariant. The default value is 1.0.

If you, for some reason, want to correct the level of measured data, you may alternatively use a formula in the adjust macro. Be careful to avoid double corrections.

### 4.15.4. Split model result

Split model results is useful when you want to highlight an interesting episode or if you want to split a long model time period into shorter ones for further processing.

Split model result operates on all variables in the selected model result.

The full extent of the **Time period** for the selected model result is automatically entered. Change the values for **Start date** and **Stop date** to match the subset you want to extract.

After execution, a new model time period is stored as Time Period result in Dispersion. The name is "Splitted data from XXXXnnnn.RES". You can view start data and stop date for the subset in Dispersion under **Weather**.

### 4.15.5. Merge model results

Merge model results is useful if you have a set of model results, say twelve monthly calculations, one for each month in a year, and you want to merge them into one dataset for further evaluation. Merge model results operates on all variables in the selected model results.

**Select** the model result that you want to append. It is possible to append a third and fourth etc with **Select another**. You can choose among all saved results for the specified model and user.

After execution, a new model time period is stored as Time Period result in Dispersion. The name is “Merged data from *XXXXnnnn.RES*”.

#### **4.15.6. Combine model results**

Combine model results allows the user to take several single fields or time series of fields and combine them using arithmetic expressions into a new single result.

Combining results covering different geographical will give the geographical intersection area of the results. A new grid will be calculated and applied to that area.

Combining only single fields will result in a single field.

Combining time series fields will result in a time series of fields where there only exists fields for the time stamps that occurs in ALL input time series (intersection in time).

Combining one or more time series with one or more single fields will combine the time series as above and the single fields will be applied to all fields in the time series.

## 5. Indico Presentation

### 5.1. Introduction

The Indico Presentation module is a tool for analysing data in the time series database. This is data that has been collected automatically by the Indico administration module, data imported using Waved or the ASCII interfaces in the system.

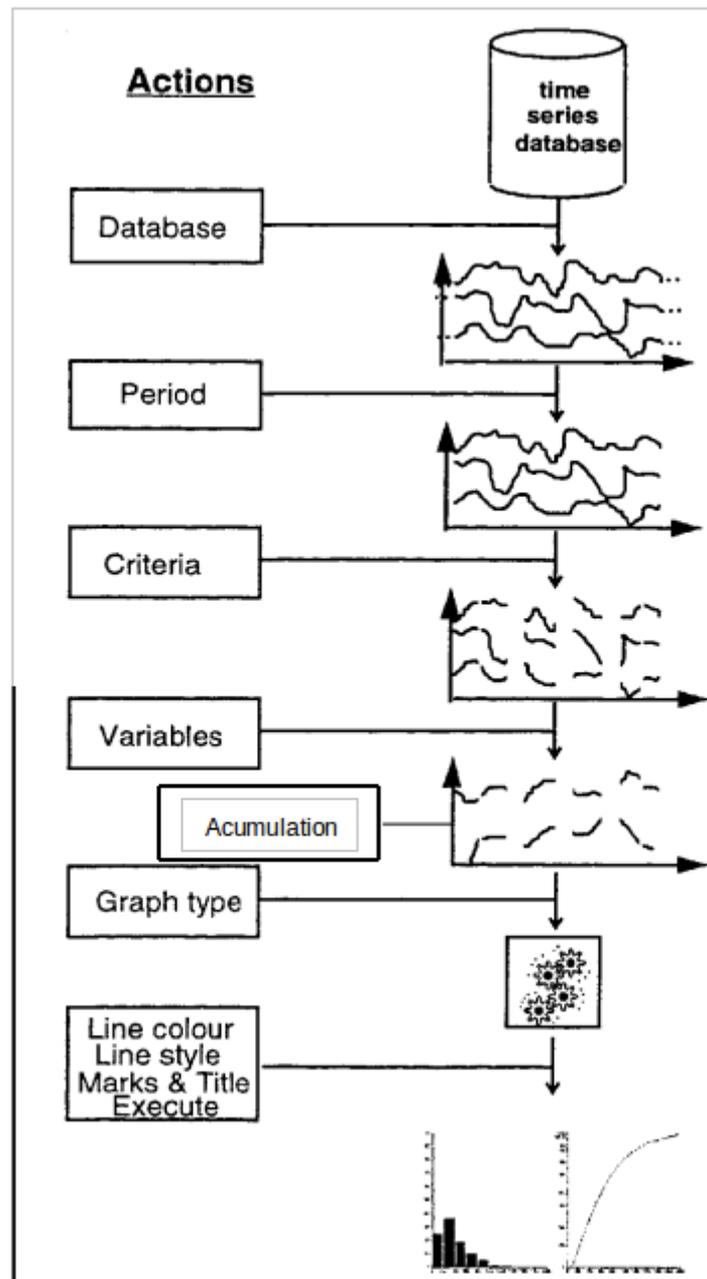


Figure 10: Data flow through Indico Presentation

Several selection criteria can be used for the data presentation including time periods, day types, range limits as well as logical rules using Boolean functions. It is also possible to

apply transformations to the original data using combinations of analytical mathematical functions. There are in addition a number of statistical analysis tools available.

An additional product, **Waved**, that is a plug in to Excel permits data to exported or imported directly from Excel. (See *Appendix 3C Waved . Working with Indico Presentation. Volume 3 . Airviro User´s Reference* for more information.)

Graphs are presented in their own window. Zooms can be made in time series graphs. The zoom can be restricted to the x axis or it can be made in both axes.

A textual representation of all graphs can be output to a window.

A text can be added to a time series graph.

Running average can be specified by start , center or end of interval.

The Indico report interface has been completely redesigned and is now easy to understand.

## 5.2. Basic Functions

### 5.2.1. Data Selection

Up to fifteen series (x1-x15) can be selected for reference and up to four series can be presented on the same graph. The following can be defined in order to select data for presentation.

#### DATABASE

##### **Station**

This defines which measurement site is to be used

##### **Parameter**

This defines what is measured, such as the concentration of a certain gas, the air temperature or the wind direction

##### **Instance**

This is used to differentiate between several measurements of the same parameter at the same site. In the case of DOAS measurements, the instance indicates which light beam has been used for the measurements. In the case of meteorological mast measurements, the instance should indicate the height at which the measurement has been made. This component can also be used to differentiate between measured values and calculated values for a parameter (in which case the instance might instead be named CAL).

##### **Attributes**

This component describes the available properties of the measurement. For example in the case of open path measurements, the data type could be value, standard deviation, light intensity or status. All of these properties belong to the same observation.

PERIOD	The period of time for which data are to be presented.
CRITERIA	Data can be selected using Boolean algebra (e.g. $x_1 > 5$ & $x_2 < 3$ ), as well as the following time criteria: <ul style="list-style-type: none"> <li>• An interval specifying certain hours within the day</li> <li>• One of the days within the week</li> <li>• An interval specifying a period within the year</li> </ul> <p>In addition it is possible to define different day types on installation (e.g. national holidays, working days) and the data viewed may be restricted to one of these day types. Data can also be selected based on quality, i.e. on the status value associated with each observation.</p>

## 5.2.2. Graphic Presentation

The following presentation options are available:

Time Series	Simply presents the selected data.
Bar Chart	This graph consists of vertical bars (rectangles) for each value.
Filled Time Series	Time series graph with a time scale on the abscissa and one variable on the ordinate axis. Both axes are linear and continuous. The areas are coloured according their scale and user settings.
Frequency distribution	This shows both a frequency bar chart and the cumulative distribution.
Scatter	Up to 4 scatter plots with the same dependent variable can be presented simultaneously on the screen, with an optional regression line. The correlation coefficient is also calculated.
Breuer	This is a polar diagram where a parameter is plotted against wind direction. The 360 degrees are split up into sectors (the user can specify the sector size) and a chosen percentile value is shown for each sector.
Mean/Sector and Freq/Sector	Diagrams showing mean value per sector and frequency per sector can also be shown (e.g. wind rose).
Diurnal variation	Illustrates any daily patterns in the data.
Weekly variation	Illustrates any weekly patterns in the data.
Annual variation	Illustrates any annual patterns in the data.

The user can also specify the following for graphical presentation:

- A title at the top of each presentation.
- Reference levels for one of the parameters shown.

- A choice of different line styles and colours.
- Toggle on/off for grid overlay, texts, axes and labels.
- Output can be: EXCE, PDF, GIF and text.

Moving average can also be used. It is a symmetric function showing the average value for each point, where the average is calculated from values both before and after the point. The size of the moving average can be defined, as well as the minimum number of data to be used in each average calculation.

### 5.2.3. Data Analysis

A selection of arithmetic, relational, logical and mathematical functions are available for performing transformations of the data. These functions are described in Appendix E4 "Calculation Formulae".

### 5.2.4. Data Storage and Data Output

- Indico macros: Specifications of selection criteria, calculation formulae, presentation format, graph types and reference levels can be named and saved for future use. Macros are stored in a separate group for each user, but there is also a Common group, which is generally available to all users. Users may view macros created by other users.
- Printing: Graphs displayed can be stored to a PDF file.

## 5.3. Statistical Models

The following are available:

Stepwise regression	This is a multiple linear regression model based on a stepwise procedure. Estimation of a best model can be based on so called F-criteria or a cross-validation technique.
REEP	This stands for Regression Estimation of Event Probability and is based on the stepwise regression method. The difference is that the dependent variable is transformed to a binary variable that has the value TRUE or FALSE.
Factor analysis	This function can be used to determine to what extent a number of time series have similar or different behaviour by extracting the eigenvalues and eigenvectors from the matrix of correlation.
Principal component analysis	This function can be used to split up a number of time analysis series into a group of orthogonal principal components. This will show how dependent the time series are, and it is often the case with correlated time series that fewer principal components can be used to

completely describe the whole set of time series.

The regression model and methods used in factor analysis are described in Appendix E1.3 "Factor Analysis".

## 5.4. Air Pollution Index

Functions are additionally available that can be used to calculate an Air Pollution Index.

The API (Air Pollution Index) is a mathematical function, which transforms a concentration of one or a number of substances to an index value. This is illustrated in the following graph:

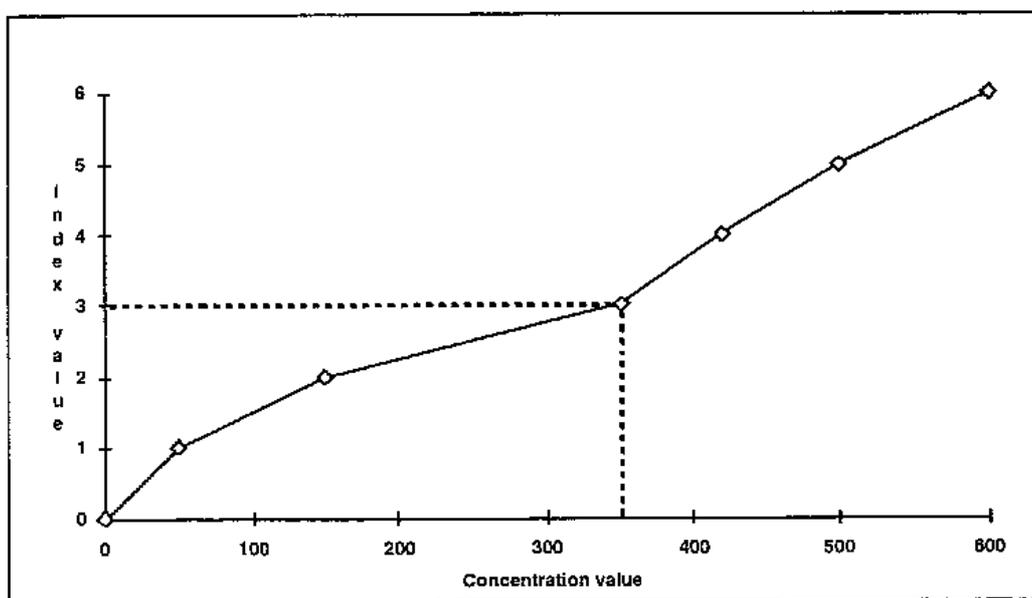


Figure 11: Air Pollution Index (API)

See Appendix E4.6 "The Air Pollution Index (non-basic optional function)" for further details of how the API is defined.

## 5.5. Real Time Graph

Once the user has defined data for presentation using the Indico Presentation module, the specification can be saved as a macro. Macros that start with the string "Auto" are used by the Real Time Graph in Indico Presentation.

The presentation is updated regularly, each macro being displayed for 15 seconds at a time. The time axis is updated with each new presentation, so that the most recent end of the time axis always corresponds to the present point in time.

## 6. Indico Administration

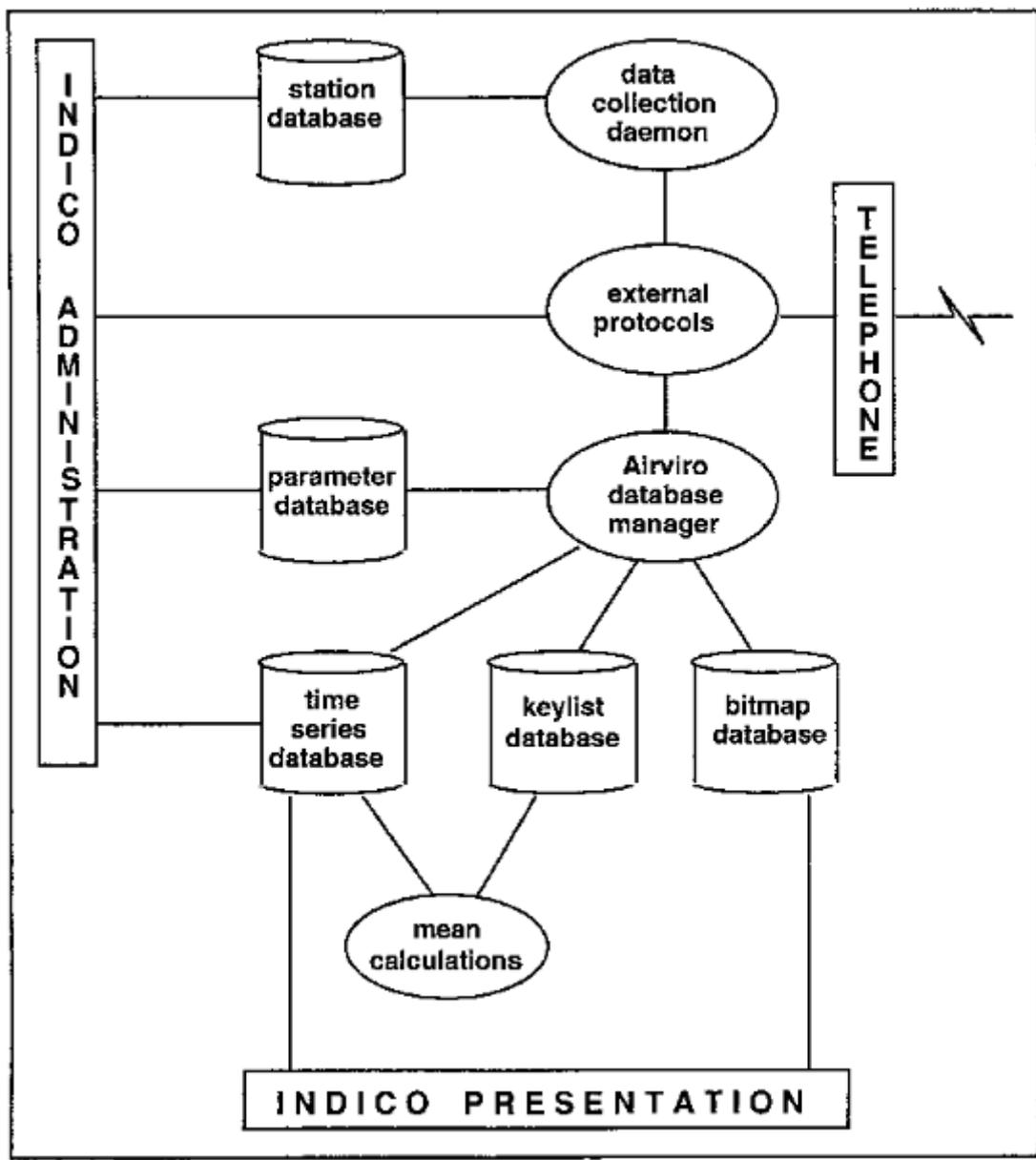


Figure 12: The relation between databases and the Indico modules

### 6.1. Introduction

The Indico Administration module is used to control and monitor the automatic acquisition of time series data from equipment for monitoring air quality and meteorology. It includes menu-driven functions for sequencing of data collection activities, quality evaluation of incoming data and manual data correction. A new interface that permits the user to control the data collection has been added.

The configuration for how Airviro dials up different stations and which data to retrieve was in v2.3 edited separately. This configuration is edited together with the other station information in 3.11.

Calibration has been replaced with the new module Indico Validation.

## 6.2. Basic Functions

The Indico Administration has been designed to make it easier to control and monitor data collection activities. This module provides the user interface for the time series, station, and parameter databases.

### 6.2.1. The Station Database

A station is a description of the geographical position of a data collection site and can also contain data collection sequencing information and statistics for the measurement site. Each measurement site that is equipped with a Data Acquisition Unit (DAU) that has a specific protocol which describes data interchange with Airviro. A list of the protocols currently supported by Airviro is included in Appendix A7 "Data Loggers for Automatic Data Collection". Data may also be entered manually if automatic data collection is not possible.

An interface to the station database is provided, which can be used to control and examine the following:

- How often each station is to be called for data collection. Time windows can be specified, so that given stations are only called during specified parts of the hour, day and week.
- An indicator showing how much data has been retrieved from the station up to and including the last successful data collection cycle.
- A counter for failed calls. Call and retry intervals.
- A reference to the relevant external protocol (description of how data are to be collected) for the station DAU.
- Each station can belong to one or several station groups. In addition, station groups can be used as a way of handling mobile stations, where each mobile station has its own station group.

The station database is described in detail in Appendix C2.1 "The Station Database".

### 6.2.2. The Parameter Database

A parameter is a measured quantity such as sulphur dioxide concentrations or wind speed. Information about each parameter to be handled by Airviro is stored in the parameter database. This information includes the following:

- graph presentation information
- quality criteria for observed values

The database is described in detail in Appendix C2.2 "The Parameter Database". An interface to the parameter database is provided, allowing the user to change the contents of each record and to create new records.

In order to enable consistency between different modules in Airviro, measurements should be expressed in SI units and especially concentrations should be expressed as mg/m<sup>3</sup>.

### 6.3. Data Collection

In order for the Airviro workstation to be able to communicate with a DAU, an external protocol especially written for use with this type of DAU must be available. SMHI owns a specially developed high level, script-based programming language, which can be used to write external protocols. This is described in more detail in Appendix B3.4 "Creation of New External Protocols".

The external protocol editor enables the user to alter the configuration files for the external protocols used for data collection. The configuration files are described in detail in Appendix D2.4 "External Protocol Configuration File (xpr file)", and the flow of data and control in the data collection process is described in Appendix B3 "Data Collection and Distribution".

Actually data collection in Airviro supports the following low level communication protocols: TCP-IP, GPRS, Direct Line, RS232, Dial Up line, Radio Modems and GSM/3G.

In summary, these subwindows allow the user to specify information such as the following for each station:

- The telephone number.
- The password to the DAU (if relevant).
- The parameters measured in each channel of the DAU that is the database key to be associated with data from the channel.
- Available processing options to be performed for data from each channel.

Note that data collection should be run through a direct line to the local telephone exchange and should not go through any company switchboard.

The Data Collection window shows the processes that are under the control of the data collection daemon (**cold**), together with their current status.

### 6.4. Database Management

A special data collection manager coordinates and optimises all data collection activities, especially for systems with large numbers of data collections sites (stations) and collection devices. Stations usually wait in an IDLE queue until it is time to collect data when they are moved to a WAITING queue. Here stations wait until the first available valid collection device is available (different stations may need to use different collection devices such as modems with different baud rates). Data collection then begins and the station is moved to

the RUNNING queue. Several stations may be in the RUNNING queue at any time, depending on the number of devices on the system.

When data collection is complete, the station is updated and returned to the IDLE queue and the device is freed ready for use by another station.

## 6.5. Distribution

Airviro can distribute data to one or more systems. The user can save time series data for distribution. Airviro saves this data in file that is located in `usr/airviro/data/<domain>/dist/`. Using the Dist, Fdist and Hdist protocols data can be sent to other Airviro systems.

## 6.6. Post Processing

Airviro can process data. When data enters into the time series database it is possible to define what post processing that will be made with the data. Typical post processing is calculation of averages and sums but also to scale raw values to scaled values. ( See Using the *Indico Validation Module*. Volume 5. Airviro User's Reference)

## 6.7. Data Checks

Airviro can check the data. It is possible to define various limits to check the incoming data.

Data checks are normally being made per parameter but here it is possible to add checks based on time series. It is made defining rules, which applies to all incoming time series data.

## 7. Indico Validation

### 7.1. Introduction

Indico Validation is - together with Indico Admin, Indico Report and Indico Presentation - part of the integrated Indico package intended for acquiring, storing, editing, presenting, analyzing, validating, reporting and exporting time series data.

The data is normally captured from the data logger configured using Indico Administration module. Collected data is stored as raw data if this status flag is assigned to the parameter in the protocols settings within the Indico Administration.

The Indico Validation module is used to validate measured data. These data are stored in the Time Series Database. It includes menu-driven functions for checking and editing the data and to input manual data corrections.

It also allows the user to validate the data loaded as macro. The macro are previously created using the Indico Presentation module.

### 7.2. Basic Functions

The Indico Validation provides an interface to the time series database. Data can be viewed in tabular form, and users with special privileges are also able to alter or delete data here. Time series data that have been changed using the editor are by default marked with a special status indicating that they have been changed by a user. Formulae can also be applied to selected data.

With Indico Validation oen can view or edit the contents of the time series database. If raw (not scaled) data has been stored in the time series database, one can configure scaling of them and then have both raw and scaled data in the database.

### 7.3. Session

Each session shows up to 8 Time Series of data for a time period, both raw and scaled data will be loaded for each time series if available. The raw data is never modified in any way but the scaled data may be edited or changed by adding, changing or deleting scaling. If no raw data is available, no scaling can be applied and it is only possible to edit data.

### 7.4. Interface

Indico Validations has a user-friendly interface that allows the user to display the data that it is stored in the Time Series Database.

Spreadsheet	Spreadsheet contains an active time window, which usually is a subset of the whole session. The active window may also contain one value that has keyboard focus (marked with a black square).
Graph	If no time series in the spreadsheet has focus, all time series in

	<p>the session will be shown. Graphs will be colour coded per time series in the same way as the time series labels in the spreadsheet.</p>	
	<p>If one time series has focus, only that time series will be shown. Graph will be colour coded by value status in the same way as the data in the spreadsheet.</p>	
	<p>The active window is marked with a light grey rectangle in the graph.</p>	
Graph	<p>Any Scalings are marked with triangles at the top of the graph area. Active Scalings have a dark triangle and inactive ones have a gray triangle. If a scaling is selected in the Scalings list, the corresponding marker in the graph will be slightly lower than the others.</p>	
	<p>When a shorter time period is shown, each value is marked with a diamond. This disappears when there are too many values to be shown.</p>	
Scaling	<p>If there are raw data available, the Scalings interface will be shown to the right of the graph. Here it is possible to add, edit and delete Scalings.</p>	
Axis	<p>If auto scaling of the x-axis is enabled, the application will try to find the best possible scaling. It is also possible to enter manual limits to the x-axis. To enter manually the Y-axis scale, just type the min and max value for it in the test boxes and press enter after that.</p>	
Fonts & Columns	<p>The size of the text in the spreadsheet and the number of columns can be selected. These settings will be saved in a cookie between sessions.</p>	
Settings	Show raw values in graph.	Controls the showing of raw values in the graph.
	Show supporting lines from y-axis.	Draw horizontal support lines from y-axis in the graph.
	Immediate auto-rescaling of y-axis.	Instead of having to push the Auto button, the y-axis is recalled as soon as focus changes or a scaling is update.
	Auto minimum on y-axis	Also set minimum on y-axis automatically. Default is to use 0 as minimum.

Show focus value info windows

Enables a info window to be shown over the graph when left mouse button is pressed and held. Info contains date/time , raw and scales value for the position of the mouse pointer.

## 7.5. Mouse

Mouse functionality is presented below.

Clicking on a spreadsheet value will set focus to that value. Clicking on the time series labels to the left will remove focus from an individual value.

Left clicking on the graph will set the focus on the nearest value and move the active window so that it is centered around the value. Pressing and holding down the left mouse button will allow interactive dragging of the active window. If the focus value info window is enabled (see Settings above), the floating info window will be shown as long as the left mouse button is pressed.

By pressing and dragging using the right mouse button, it is possible to zoom into a smaller time period.

## 7.6. Ratify Data

The user can ratify data, i.e. making some fine tuning of the data and then save the data to a new instance.

The "Ratify" function is more or less the same as "Validate". The main difference is that when you press "Apply", you can enter a different instance to save the data in. This means you can save it as ratified data under another instance, e.g. named RAT.

## 7.7. Scaling Data

The user can enter scalings. All scalings for a certain time, station and type of scaling are grouped together and it is possible to add, edit and delete scaling for the station.

## 7.8. Data Scaling Formulae

Different Scaling Formulae are applied depending on the system configuration.

### 7.8.1. Scaling formula – Raw

In this case the values received from the logger/instrument are unscaled, e.g. mV values.

$$V_{scaled} = (V_{raw} - Z_u) \frac{CC}{(S_u - Z_u)}$$

Where:

Vscaled	The scaled value calculated in Airviro.
Vraw	The value received from the logger/instrument.
Zu	The zero point entered.
Su	The span point entered.
CC	Span gas cylinder concentration.

### 7.8.2. Scaling formula – Scaled (by calibration)

---

In this case the values received from the logger/instrument are scaled using the latest valid calibration.

$$V_{scaled} = (V_{raw} - Z_m) \frac{S_u}{(S_m - Z_m)} + Z_u$$

Where:

Vscaled	The scaled value calculated in Airviro.
Vraw	The value received from the logger/instrument.
Zm	The zero point measured in calibration.
Sm	The span point measured in calibration.
Zu	The zero point entered.
Su	The span point entered.

### 7.8.3. Scaling formula – Linear

---

In this case the values received from the logger/instrument are scaled using a linear transformation. Useful for entering multipoint calibrations.

$$V_{scaled} = V_{raw} \cdot L_k + L_m$$

Where:

Vscaled	The scaled value calculated in Airviro.
Vraw	The value received from the logger/instrument.
Lm	Offset.
Lk	Slope.

### 7.8.4. Scaling formula – Linear 2

---

This is just another variant of the Linear transformation above.

$$V_{\text{scaled}} = (V_{\text{raw}} - L_m) \cdot L_k$$

Where:

$V_{\text{scaled}}$	The scaled value calculated in Airviro.
$V_{\text{raw}}$	The value received from the logger/instrument.
$L_m$	Offset.
$L_k$	Slope.

## 8. Indico Report

### 8.1. Introduction

Indico Report is - together with Indico Administration and Indico Validation - one of the three main tools in Airviro Air Quality Management, intended for acquiring, storing, editing, presenting, analysing, reporting and exporting time series data.

Indico Report is a powerful tool for reporting data stored in the time series database.

### 8.2. Report Types

A set of eight standard output formats (called process types) is provided.

Report output can be sent as email, saved as a file or printed. In case of an email the destination email address is entered in the text box. In case of a file the full path of the filename is entered in the text box.

#### 8.2.1. Average

Displays the selected time series data together with the average value and the standard deviation. Up to eight time series can be selected. You also write a title and select a format. If you have specified hourly values then the instance will be for the previous day, if you have specified daily values then the instance will be for the previous month. It is also possible just to indicate a specific number of hours back in time.

#### 8.2.2. Cumulative

Produces a more complex output of cumulative ratios, data capture and maximum and average values. You set up the cumulative ratios by first choosing a number of levels, the distance between each level and the value for the first level. Alternatively you can select 8 levels. The percentage of data that is below that level is calculated for each level. The result is a table showing percentile values. Again, if you have specified hourly values then the instance will be for the last day, if you have specified daily values then the instance will be for the previous month. It is also possible just to indicate a specific number of hours back in time.

#### 8.2.3. General

It uses a saved Indico macro and produces a listing of data in a tabular format. You can choose a day, week, month, quarter or year. The instance will then be for the day, week, etc. previous to the specified date. When specifying a macro; title, restrictions and time series will be used to generate the output. The unit slot in the variable selection will be used for heading each one of the columns. When specifying the setup you can select the time period and resolution to be used. The higher resolution depends on which database you have available, e.g. it could be 5 minute, quarter hourly, etc.

The resolution or the time period is used for computing the total averages, maximum, minimum and standard deviation values that appear at the bottom of the table. An additional summary is also given for the resolution of the table.

#### **8.2.4. Macro**

It uses a saved Indico macro, keeping all the same information except the time period, which can be specified by the number of hours worth of data that you want to include in the graph. In this case the printout is graphical, and you can select output format. The stop time of the graph will be the end of the specified time period unless a number of hours forward has been specified.

#### **8.2.5. Plain**

It lists the data that you have selected for a specified number of hours. The stop time will be the specified time. Output can be plain ASCII text, SKV format (e.g. for importing to certain spreadsheet programs) or Airviro standard format.

#### **8.2.6. Alarms**

It uses alarms stored in the events database. The user can select the following options:

- General: category, level and field (alarm Id, begin, end, category, system, level, description, station, time) will be defined for a specified time.
- Alarm daily v/s level: daily events specifying levels. An additional sum and percentile is also given for the resolution of the table.
- Alarm hourly v/s level: hourly events specifying levels. An additional sum and percentile is also given for the resolution of the table.
- Alarm monthly v/s level: monthly events specifying levels. An additional sum and percentile is also given for the resolution of the table.
- Time v/s level: when specifying hours limit (until 4) will be a specific number of hours back in time.
- User v/s level: only specify a number of days back.

#### **8.2.7. Matrix Monthly**

Time series and report title will be used to generate the output. This report produces a matrix table with the following data: day, hour, parameter value of the selected station and statistics data.

### 8.2.8. Summary

You write title and selected report period. Then, selected Domain, time resolution and time series.

It is also possible to indicate a calculate specific:

- Running average: raw, 1-3-8-24hs
- Number of processing: 1 a 8
- Type: average, maximum, minimum date capture, percentile, exceedance, n-th maximum

Output can be format: pdf, csv, excel and open office spreadsheet.

## 9. Indico Alarm

### 9.1. Introduction

Alarms can be used to notify a user when high concentrations are measured but also to notify when an instrument or communication is failing.

Each alarm can be defined with three different levels: **Warning, Alarm or Alert**. The different levels indicate different levels of seriousness. An alarm contains rules that are made using Indico formulas. To each alarm actions can be defined. Actions include sending of emails or to notify users, I e display the alarm in the alarm viewer. The defined alarms are stored in a database.

A background process (The Airviro Alarm process) maintains a list of alarms and performs checks according to the rules in the alarm. It maintains a list of active alarm instances and is able to re-create the active alarm instances upon restart.

When an alarm is activated, and if a notification has been configured, the alarm is displayed in the alarm viewer.

The alarm viewer can be started either from the Module *RTAlarms* or *Indico Real Time* and is used to view and acknowledge the alarms. See *Figure 9.1*

The alarm history is stored in the event database. The user can search for alarm instances stored in the event database, either by name (**Alarm ID**) and/or by selected period.

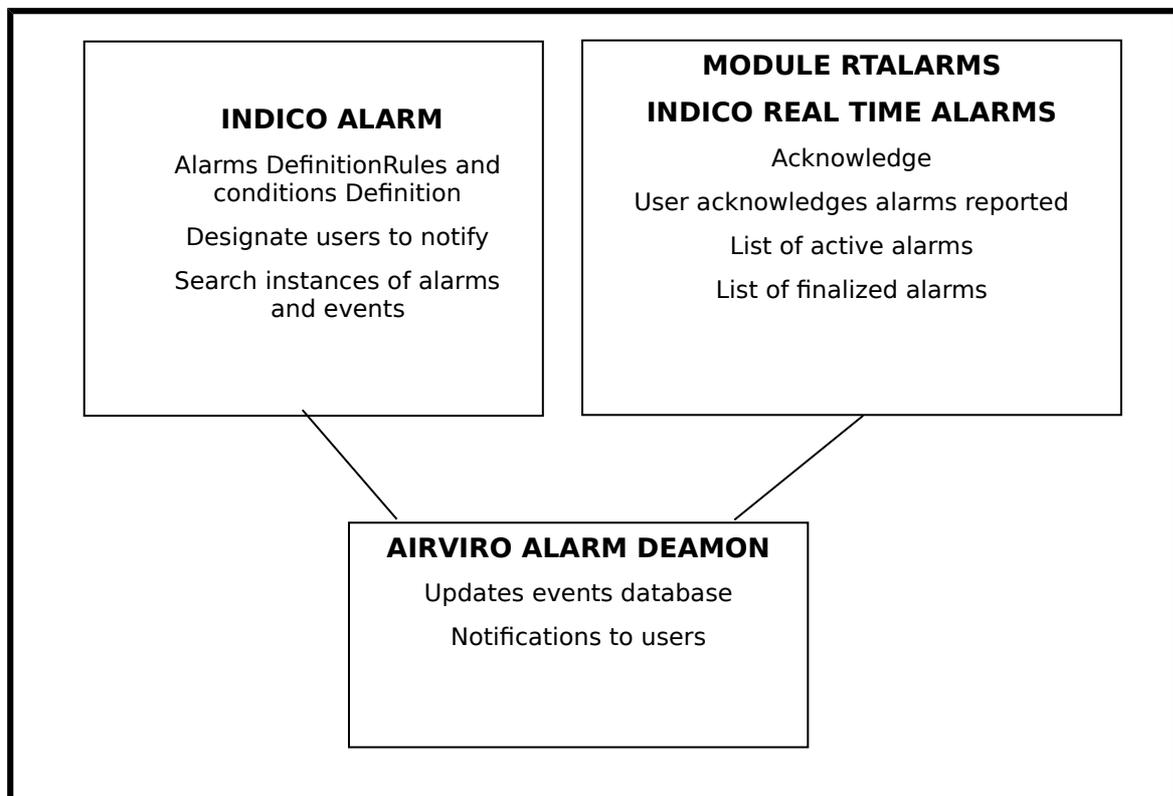


Figure 9.1. Functionality

## 9.2. Basic Functions -Template definition

In the Alarm Module, you can define alarms, search alarm instances and configure templates for email notifications.

The user can define the content of an email notification using free text and the variables below:

- **alarm\_id** Alarm identifier.
- **alarm\_name** Alarm name.
- **alarm\_stn** Alarm station id.
- **alarm\_stnname** Alarm station name.
- **alarm\_desc** Alarm long description.
- **alarm\_date** Start date of alarm.
- **start\_time** Start time of alarm.
- **start\_date** Indicates the starting day.
- **level** Alarm level.
- **category** Alarm category.
- **variables** Measurement variable values.
- **variables verbose** A more extensive description of the measurement variables and their values.

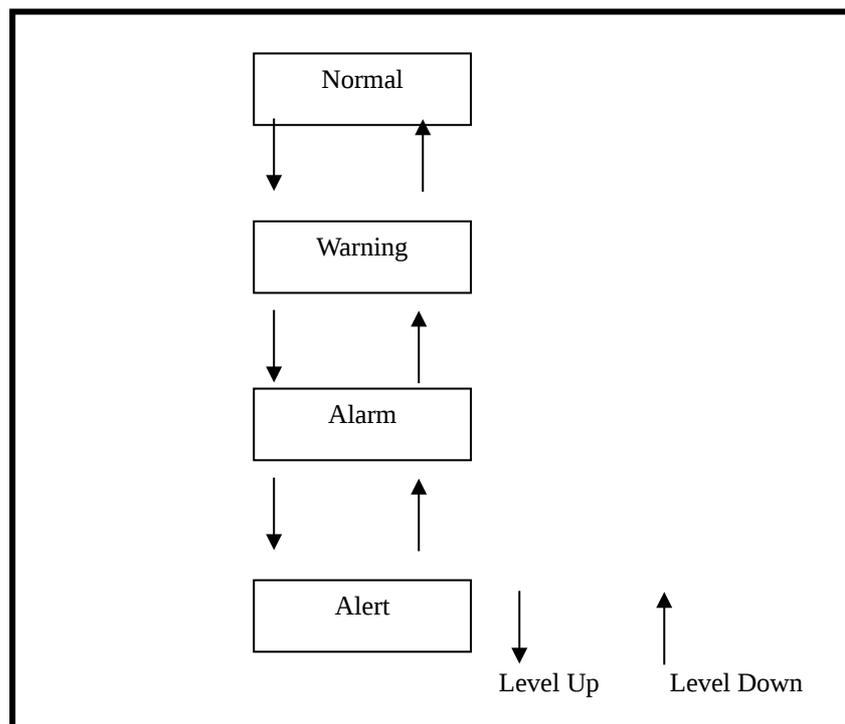
## 9.3. Alarm Definition

The user must select the domain in order to:

- define new alarms,
- modify a defined alarm
- search in the list of alarms,
- delete of one in the alarm list

In **Alarms Definition** window, an alarm is identified with a name that consists of a station identifier and a short name (3+8 alphanumeric characters). A description of the alarm can be defined as well.

The alarm can be related to 3 different kinds of **sources**: time series, a monitoring station and/or devices connected to the server. For each **source** conditions or rules must be defined. When an alarm becomes active it will get one of the three available levels: warning, alarm and/or alert. See *Figure 9.2*.



*Figure 9.2. Alarm Level*

When alarms are activated, the level goes up and if a notification has been configured, a **notification** is generated

### 9.3.1. Source

The system allows three kinds of monitoring alarms (**Source**). They are:

- **Time Series:** The alarm is defined using the Indico time series database. It is possible to define:
  - \* Formulas to activate alarms for different levels.
  - \* Number of values to check for an alarm.
  - \* The minimum number of values of the number of values that are checked, for whom the formula indicates a true condition.

\* If a peak alarm should be generated or not.

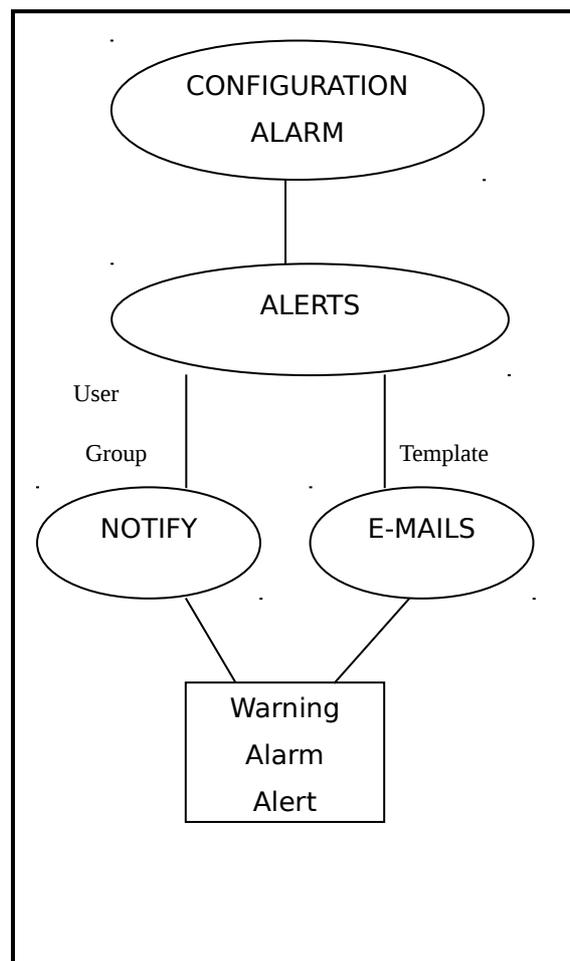
- **Station:** The alarm is defined using the bad call counter for stations. The user defines bad calls limits for warning, alarm and alert.
- **Device:** The alarm is defined on devices specified for data collection. i.e.: `/dev/ttyS0`. The user defines bad calls limits for warning, alarm and alert.

### 9.3.2. Actions

In the Alarm Definition, actions can be configured for the different users. An action is to send an email to an email address or to send an alarm notification to a certain user. The notification is viewed using the Alarm Viewer.

A notification definition contains for each level, a userid to whom the notification will be sent.

An email definition contains a link to a template for the email and for each kind of change to and from a level, email addresses for the receivers of the email. *Figure 9.3.*



*Figure 9.3. Notifications*

## 9.4. Search Alarm instances

The user can search for alarm instances stored in the events database, either by name (**Alarma ID**) and / or a selected time period (From-To).

The **Search** menu displays a list of alarms instances according to the selected conditions (*alarm Id* and/or period) and for each instance displays the events that took place for that level.

The user can add a comment to an instance and it will be saved in the events database as a new event.

An alarm is active until it goes to the normal level and can produce a series of events:

- Alarm instance creation.
- Alarm instance end.
- Transition between states.
- Notification sent to user.
- Acknowledge received from user.
- Comment by user.
- Not acknowledged by user.
- E-mails sent to recipients.
- Data missing.
- Peak.

Each event also has two times associated with it. One time when something happened and the other time that represents the alarm instance *id* start time.

## 10. APUB

### 10.1. Introduction

The APUB Module allows the Airviro users to publish environmental data on the Internet, showing real time data or historical data for a selected period.

It includes reports and interactive graphs presenting meteorological and air quality data. Emissions and dispersion calculations can be presented as well.

### 10.2. Basic Function

The basic function for the APUB module is to make a public web site for Air Quality data. To allow this APUB provide a framework for the web page and a number of web objects to display the information..

### 10.3. Available Objects

Actually 6 predefined web object are available in the APUB module.

#### 10.3.1. Indico Web Objects (IndicoWeb2)

With this object time series graphs can be added to the web page. The user will be able to select the time period and a graph from a list of pre-defined graphs.

The graphs can show meteorology data (i.e.: wind and temperature) or ambient data (pollutants). They must be previously saved as an Indico macro using the Indico Presentation Module.

This object also allows the user to download time series data in *pdf*, *text* and *excel* format.

#### 10.3.2. Map Object (StationWeb)

Allow to displayed stations on the map. It is possible to select stations on the map and display the information about the station..

#### 10.3.3. Values on map Object (StnColWeb2)

Display stations on a map. The stations are colour referenced according to predefined levels and colours.. With the mouse over functionality the latest available value is displayed. For example it is possible to display an Air Pollution Index (hazardous, unhealthy, poor, moderate and good).

#### **10.3.4. Combined Object (CombinedWeb)**

This object displays a combination of texts, graphs and maps. Several substances are shown in a matrix. Typically the matrix contains substances versus locations (Urban, Rural, City centre). The colour of the item in the matrix is coloured referenced according to predefined levels and colours that are shown in a legend, beneath the matrix, the latest selected item in the matrix is shown as a coloured time series graph, typically the time series for the latest three days. To the right of the graph a map is shown. The location of the item selected in the matrix is highlighted on the map in a colour that is the same as the item in the matrix. Above the map a predefined text can be added.

#### **10.3.5. Emissions Object (EdbWeb)**

This object can make an emission calculation from emission database macros. Macros are selectable and the emission result is shown on a map.

The total emission is shown including measure units and different available formats for downloading the emission, including pdf, txt and excel.

#### **10.3.6. Dispersion Objects (DispWeb)**

This object can show a dispersion calculation result from a dispersion macro. Macros are selectable and the emission result is shown on a map.

Different formats are available for downloading the dispersion result, including pdf, txt and excel.