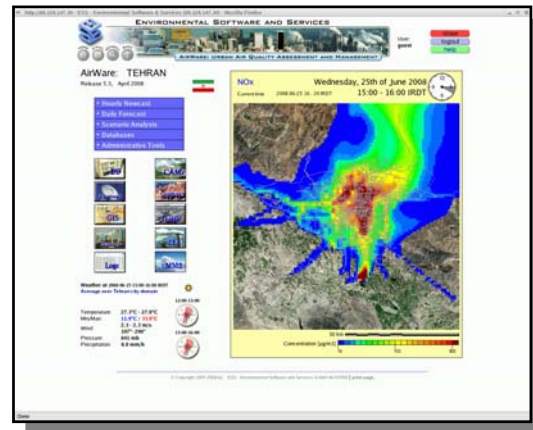


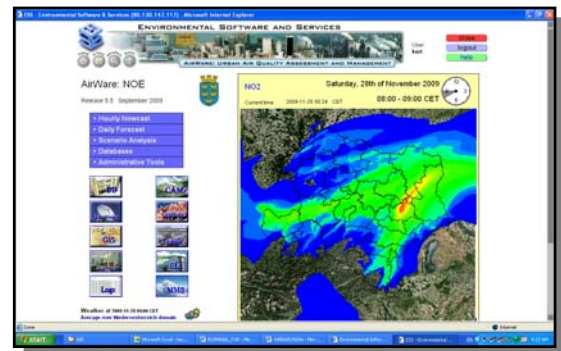
The emission dispersion modeling software must allow air quality evaluation at a local scale, on distances less than 30 km. The air quality simulation models in AirWare cover several nested domain and resolutions from 30 km (continental scale for dynamic boundary conditions using European EMEP emission inventory) to street-level solutions with one or a few meters of resolution (default for larger urban areas: 10 m). Resolution of the AirWare mode system range from 30 km to a few meters, spatial coverage from several thousand to a few kilometers (width and height of possible model domains).



The computational model used to calculate the pollutants dispersion will be three-dimensional and will support the computation of the transport and dispersion of the pollutants using the following models:

AirWare contains 3D models for meteorology, Eulerian model (CAMx), and the Gaussian model AERMOD (analytical solutions in 3D) as well as Lagrangian codes (MultiPUFF, optional alternative or addition: CALPUFF).

AirWare uses an open, modular architecture with standard open interfaces between components, a HTML/PHP based user interface (using HTML TEMPLATES users can adapt) and standard SQL database access (no proprietary data base formats) that supports the easy integration of alternative or additional models as well as model upgrades for state-of-the-art public domain models.

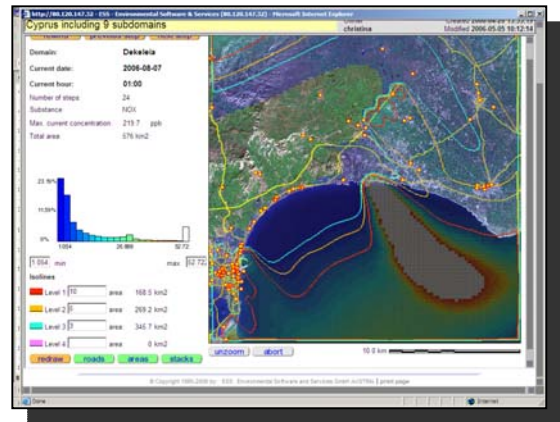


CAMx, photochemical (CB05) model domain: Lower Austria, 9,000 km<sup>2</sup>, 1 km horizontal resolution, 17 layers.

a. Gaussian pollutant gradient

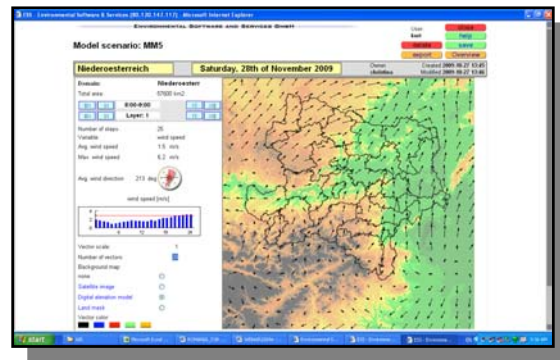
AirWare includes the USEPA regulatory Gaussian model AERMOD with advance boundary layers physics (roughness length parametrization of turbulence, Monin-Obukhov scheme) and optional terrain correction (DEM, digital elevation model, AERMAP terrain pre-processor).

The AERMOD Gaussian model can be used both for episode (hourly, with 24 hourly results per day) or for seasonal/annual runs, summary or at hourly resolution for long-term results.



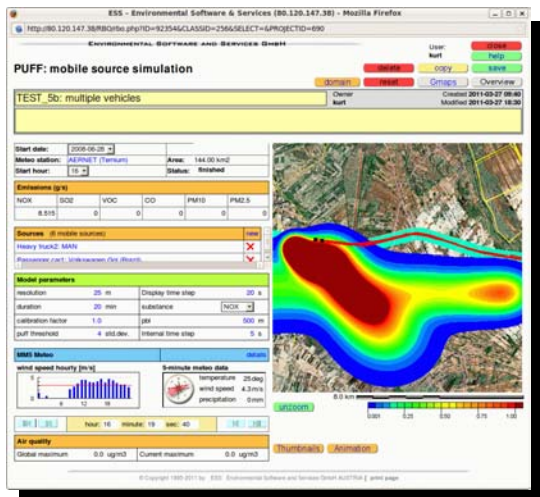
b. Trajectory – puff, particle or puff-particle combination

Lagrangian models in AirWare are based on diagnostic (AERMET, optional CALPUFF) or prognostic 3D (MM5 or optional additional or alternative WRF) meteorological models. 3D wind fields are calculated by the meteorological models or provided from meteorological observation for diagnostic interpolation. Lagrangina air quality models include both (parametrized) particle tracking or moving Gaussian plume versions of MultiPuff (default Lagrangian code in AirWare) or the optional CALPUFF including the associated CALMET pre-processor).



MM5 3D wind field for model domain: Lower Austria, 1 km horizontal resolution

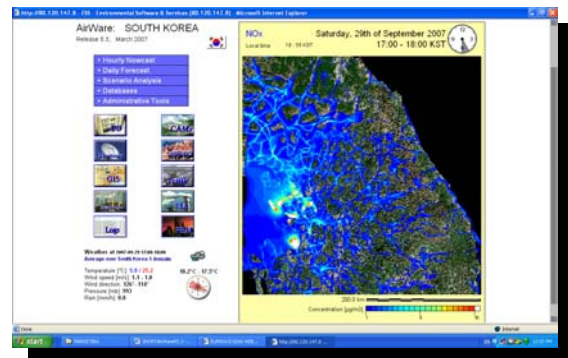
For mobile emission sources, PUFF (derived from the USEPA INPUFF model) has been adapted for very high spatial resolution (few meters) and transient fast changing situations with computational time-step of down to a second, multiple sources (mobile or stationary) including extension that can handle situation with very low or no wind, using molecular diffusion rates to develop plumes.



### c. Eulerian

AirWare integrates CAMx, currently Release 5.01 (04/06/09), with CB05 chemistry mechanism and MPI support.

The Comprehensive Air quality Model with extensions (CAMx) is an Eulerian photochemical dispersion model that allows for an integrated one-atmosphere assessment of gaseous and particulate air pollution including air toxics and metals (ozone, PM-2.5, PM-10, air toxics, mercury) over many scales ranging from sub-urban to continental.



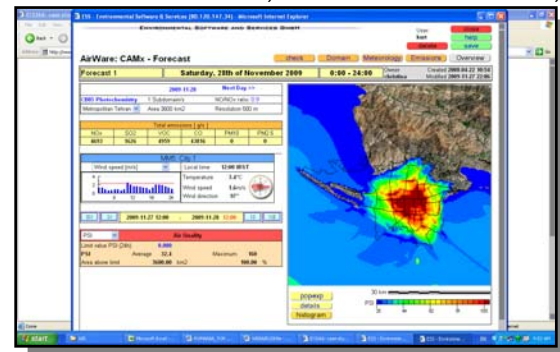
CAMx Eulerian model, domain: South Korea, 36,000 km<sup>2</sup>, 3 km horizontal

The model to be used will be chosen taking into account the complexity of the topo-climatic conditions and the terrain type, as well as the type of the sources to be analyzed.

The governing equations are expressed mathematically in terrain-following height ( $z$ ) coordinates. It considers a horizontal wind vector, net vertical entrainment rate, multiple vertical layers, atmospheric density, and turbulent exchange (or diffusion).

The terms on the right-hand side represents horizontal advection, net resolved vertical transport across an arbitrary space- and time-varying height grid, and sub-grid scale turbulent diffusion. Chemistry is treated by simultaneously solving a set of reaction equations defined from specific chemical mechanisms. Pollutant removal includes both dry surface uptake (deposition) and wet scavenging by liquid precipitation (rain).

Model domain: GTA, Greater Tehran Area,

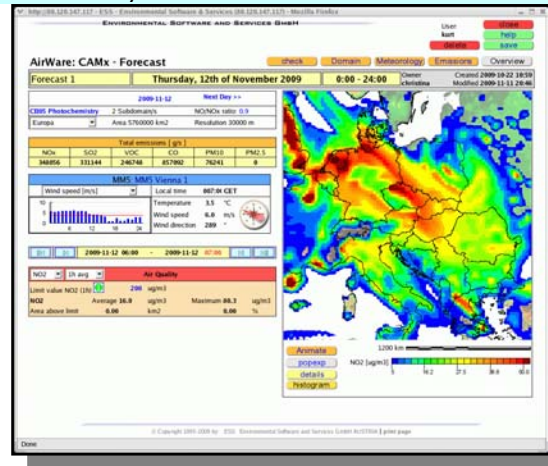


Iran, rugged mountainous terrain; 60 by 60 km, 500 m horizontal resolution

Eulerian model for analysis of background concentrations fields, including sources localized at great distances from the object been analyzed.

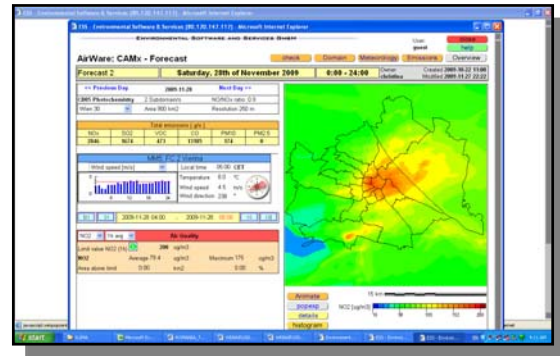
The main Eulerian model CAMx can be configured for multi-level nesting with two-way coupling, for example, from 30 km resolution at European scale to 250 m resolution for local (nested) domains.

The example demonstrates the EMEP European scale (30 km horizontal resolution, area covered: 5,760,000 km<sup>2</sup>) master domain that provides dynamic boundary conditions (hourly temporal resolution) to local/regional domains and model runs either as now-casts (3-6 hourly updates, or as daily automatic forecast for up to 120 hours.



This model needs to support a downscaling mode for local or urban scales analysis. CAMx supports fully nested (two-way coupling) high-resolution multiple (urban) sub-domains.

The example shows the application of the same model/code used for the European scale (above) at an urban scale application (city of Vienna, Austria) nested in the upper layers with a grid resolution of 250 meters, covering 900 km<sup>2</sup> (300 by 300 km model domain). The model domain is nested (two levels) within the EMEP European domain and the surrounding province of Lower Austria.

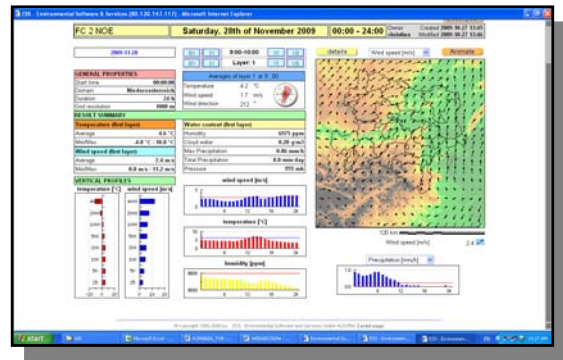




It is an advantage if this model can be coupled with a meteorological model at regional scale. The meteorological model (forecast type) must solve the equations for:

- horizontal components of wind,
- the equation of continuity,
- scalar equations for temperature and specific humidity,
- equations for turbulent kinetic energy.
- It must include complex schemes for micro-processes inside the clouds and
- must include modern parameterizations for surface flows taking into account the type of the land and the vegetation.

AirWare includes the 3D prognostic **meteorological model MM5** (optional: WRF) which conforms to all specifications (<http://www.mmm.ucar.edu/mm5/mm5-home.html>). Input data (matrices for elevation, land cover, albedo etc, are provided from the embedded GIS system. CAMx and Multi-Puff are automatically and directly coupled with the output the meteorological models in standard formats (netCDF, network Common Data Format) in the MM5toCAMx conversion program.

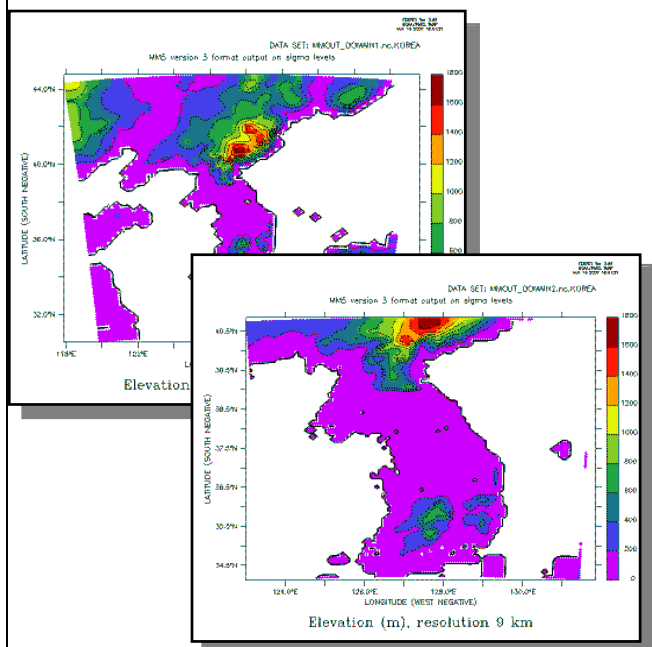


The meteorological model must be able to run in nested mode, in order to bring the resolution to finer scales.

MM5 (and the optional WRF) meteorological models accept synoptic meso scale data from global forecasting or re-analysis systems (GFS, NCEP) at degree resolutions, and use **dynamic downscaling with multiple levels of nesting** to a resolution of 1 km and hourly results for all data fields.

The resulting high-resolution meteorological data fields are directly provided as input to the air quality models. Model results are also extracted as time series for existing or simulated monitoring stations for later use by diagnostic interpolation programs for the Gaussian model AERMOD (e.g., long-term analysis for EIA).

The example shows the 27 km (58x58 cells) and second level (9 km 82x82 cells) MM5 domains for East Asia and South Korea.

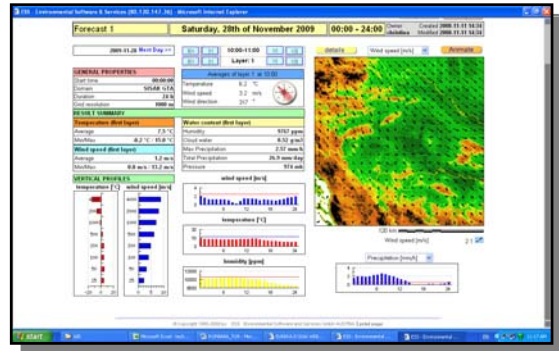




It must allow running in a hydrostatic-less mode, in order to outline some phenomena caused by the presence of topography at local scale.

MM5 is a fully 3D non-hydrostatic code. Dynamic 3D meteorological data are calculated using PSU/NCAR meso scale model (known as MM5). MM5 is a limited-area, **non hydrostatic**, terrain-following sigma-coordinate model designed to simulate or predict meso scale atmospheric circulation. The model is supported by several pre- and post-processing programs, which are referred to collectively as the MM5 modeling system. The MM5 modeling system software is mostly written in Fortran, and has been developed at Penn State and NCAR as a community meso scale model with contributions from users worldwide.

<http://www.mmm.ucar.edu/mm5/mm5-home.html>



MM5 scenario interface and results display for Sisak, Croatia (57,600 km<sup>2</sup>, 1 km and hourly output resolution)

The meteorological model can be initiated by synoptic input data (wind, temperature, pressure, humidity, the height of vertical levels).

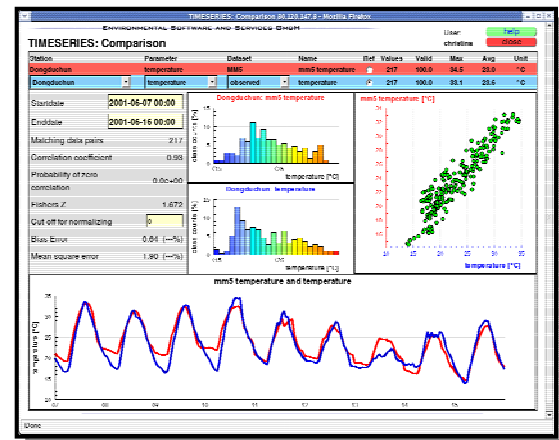
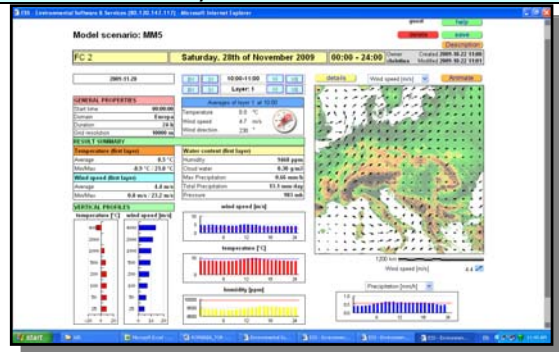
MM5 forecast is based on results of NCEP GFS Forecasts data. The **NCEP/GFS input data** are available on resolution 1°x1° with time interval of 3 hours. Datasets used include surface pressure, sea level pressure, geopotential height, temperature, sea surface temperature, relative humidity, u- and v- wind vector components. The subdomain for GFS data downloaded for various project areas currently covers

latitude 10° N - 60° N  
 longitude 0° - 360°

Automatic download of GFS forecast data from the NOAA Operational Model Archive Distribution System can be configured using:

```
nomad1 = "http://nomad1.ncep.noaa.gov/cgi-bin/ftp2u_gfs.sh"
nomad3 = "http://nomad3.ncep.noaa.gov/cgi-bin/ftp2u_gfs.sh"
nomad5 = "http://nomad5.ncep.noaa.gov/cgi-bin/ftp2u_gfs.sh"
nomad6 = "http://nomads6.ncdc.noaa.gov/cgi-bin/ftp2u_gfs.sh"
```

The examples show weather forecast for Europe, and MM5 model validation for South Korea.



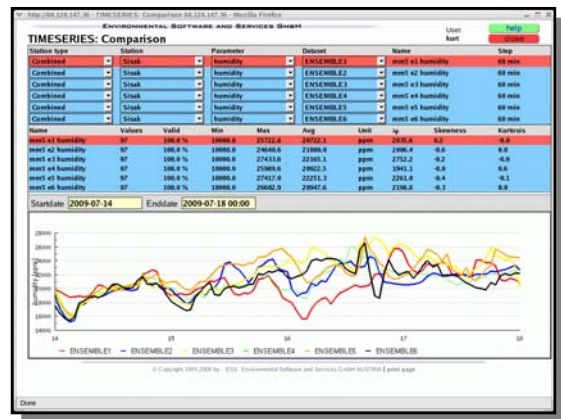
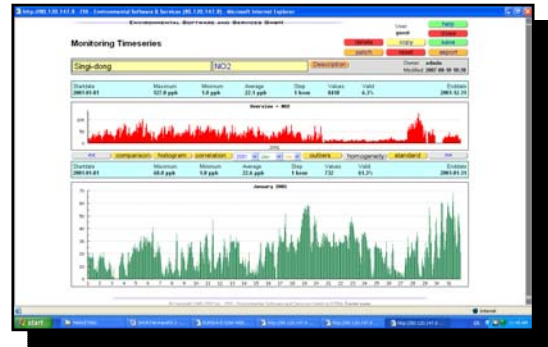
It is an advantage if the model is delivered altogether with an updatable meteo database that can initialize the system automatically every 3 or 6 hours, for the period of one year, so that the model doesn't need external input of meteorological data.

AirWare includes a (generic) data base and data acquisition system for time series, including a **meteorological data base**; this can be populated from

- NCEP re-analysis data,
- MM5 model results extracted for specific locations from long-term (e.g., annual) runs for dynamic downscaling of low-resolution NCEP data,
- or observational data from monitoring stations.

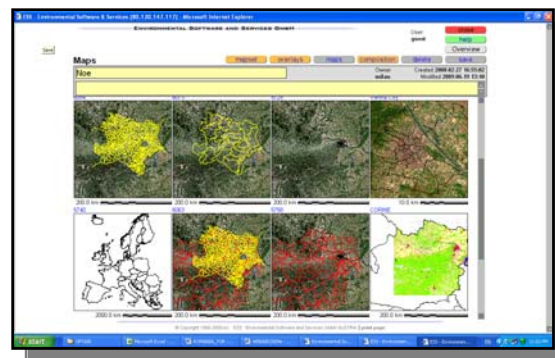
MM5 input data can be obtained every 3-6 hours with correspondin short dynamic downscaling runs of 3 to six hours, or daily for a period of several days for both regular forecast (up to 120 hours) or regular short 3-6 hour forecasts and nowcasts.

The meteorological data base also manages ensemble data for optional stochastic model runs and forecasts.



Also, supplying a database with the topography and the land use in an optimal resolution for all of Romania (which will allow the description of the type of vegetation and soil) is a plus and will ease the user's consistent effort in processing this information.

AirWare includes an **embedded GIS**, MapCatalog and MapServer system. It can be supplied with a number of **standard GIS data layers, maps and spatial data sets** that are used as background for the (geo referenced) emission data base, as model inputs, for the display of model results as background, and for impacts analysis (e.g., population exposure calculation). Standard backgrounds include: 1 km and 30 m resolution DEM, CORINE European land cover; LANDSTA TM (13 m nominal resolution) panchromatic satellite imager. In addition any maps in UTM projection can be



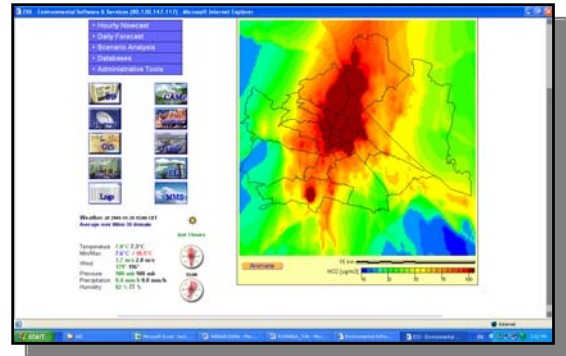
Examples from the MapCatalog for Lower Austria

imported from standard formats such as ArcView Shape files.	
---	--

The meteorological model must allow automatic export functionality to the dispersion model or to the meteorological processor that is coupled with the dispersion model.

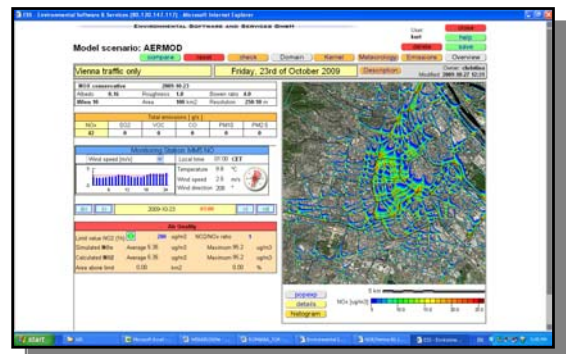
MM5 results are **automatically converted** to CAMx inputs, and exported for selected (real or simulated) monitoring stations as potential inputs for diagnostic meteorological models (interpolation) such as AERMET pre-processor for AERMOD.

For the automatic predictions and hourly nowcast runs, a summary of the meteorological scenario is displayed with the model result.



Lagrangian and Gaussian models - will be used for pollutants dispersion modeling at local scale, using the data provided by the eulerian model and the meteorological model at regional scale

Please note that GAUSSIAN models provide only steady-state solution and have neither initial nor boundary conditions; Lagrangian models are only as good as the meteorological data (3D wind fields) provided, and similar to Gaussian models, can only be used for a smaller number of sources as the model performance is strongly dependent on the number of sources (linear for Gaussian, highly non-linear in the case of Lagrangian particle tracking code; Eulerian models are independent of the number of sources, and depend on the spatial resolution (grid cells) and the implied time step of solutions only.

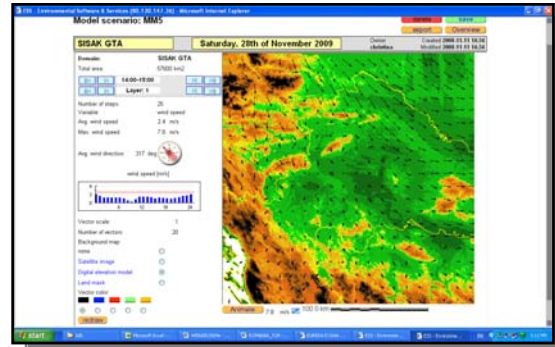


AERMOD, Gaussian solution, Vienna City center, **10 m resolution** (line source convolution results down to 1m)

The Lagrangian model will be selected by the operator specifically for complex terrain, when the the topography and heterogeneous surfaces (the model includes wind fields and heterogeneous turbulances)

Lagrangian models include Mulri PUFF (default AirWare components) or the alternative optional CALPUFF model. However, the Langrangian model has NO ADVANTAGE over the Eulerian solution, as both are depending on and driven by the **same 3D wind field** generated by the meteorological model. The quality of the model results depend primarily on the quality of the wind field generated.

The main requirements must be a high-resolution 3D wind field modeling, where one possibility is to use another layer of diagnostic interpolation (with terrain corrections) on the 1 km prognostic meteorological model output.



High-resolution wind field over rugged mountainous terrain (Sisak, Croatia)

The system must allow selecting the right model depending on the topographic conditions of the area to be analyzed

AirWare supports the **interactive selection** of any one of its alternative models for scenario analysis from the main menu. All models share the same input data such as the emission modeling and pre-processing, and meteorology.

For the automated forecast and nowcast run, alternative models can be selected for alternative domains, or configured to run in parallel. The hierarchical selection mechanism support model selection both foe automated runs and interactive scenario analysis.



Both models must allow modern parameterization for turbulences using the parameters of limit layers ( $u^*$ ,  $L$ ,  $w^*$ ,  $H$ )

CAMx uses a full non-hydrostatic 3D scheme; AERMOD uses **advanced boundary layer physics for turbulence characterization**.

AERMOD's characterization of the boundary layer with computation of the Monin-Obukhov length, surface friction velocity, surface roughness length, sensible heat flux, convective scaling velocity, and both the shear- and convection-driven mixing heights. These parameters are used in conjunction with meteorological measurements to characterize the vertical structure of the wind, temperature, and turbulence

## Monin–Obukhov Length

From Wikipedia, the free encyclopedia  
(Redirected from [Monin-Obukhov length](#))

The **Monin–Obukhov Length** is defined by

$$L = - \frac{u_*^3 \bar{\theta}_v}{kg(\overline{w' \theta'_v})_s}$$

See, for example, the AERMOD implementation guide, USEPA: [http://www.epa.gov/scram001/7thconf/aermod/aermod\\_implmtn\\_guide\\_19March2009.pdf](http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf)

Both models must include reactions and photochemical schemes

**PLEASE NOTE:**  
**photochemistry** is only available for Eulerian models( such as CAMx (or CMAQ, CALGRID) implemented as PDF (partial differential equations) neither Gaussian (which is an analytical steady-state solution of the Navier-Stokes equations of flow or dispersion) nor Lagrangian (particle tracking or using Gaussian plumes) can solve the photochemical equations as part of their dispersion schemes. Basic chemical reactions (first order exponential decay) can also be represented in Gaussian or Lagrangian schemes.  
AERMOD can be run in the OLM (Ozone Limiting Method) mode for NO2 calculations.

<http://www.camx.com/publ/pdfs/ATModelSys69437.pdf>

Development And Application Of An Advanced Air Toxics Hybrid Photochemical Grid Modeling System  
Paper # 69437  
Ralph E. Morris, Steve Lee, and Greg Vreeland  
ENVIRON International Corporation, 111 Rawland Way, Novato, California 94945

**ABSTRACT**  
An air toxics modeling capability has been implemented in the Comprehensive Air-quality Model with emissions (CAMx) photochemistry grid model that includes first chemistry of organic air toxic compounds, the treatment of both gas and particulate phase air toxics and the treatment of the same source sectors of air toxics using a multi-phase plume model. The CAMx air toxics modeling system was demonstrated using the April 1998 through March 1999 annual dataset from the Michigan Air Toxics Exposure Study (MATES-02) in the South Coast Air Basin (SCAB). The MATES-02 mobile source emissions were updated from EMFAC-03 to EMFAC-2000. The CAMx modeled air toxics concentrations using the EMFAC-03 and EMFAC-2000 emissions were compared against 14-hour observations in the 10 MATES-02 monitoring sites in the SCAB. The performance of the MATES-02 CAMx air toxics modeling system was also demonstrated using the August 1, 1997 Toluene, Carbon Monoxide Study (T-COS) episode using both the CB-TX and SARECH chemical mechanisms. Finally, risk and exposure estimates were made both increasing the and not increasing the ozone reagent effect and using both grid and box-wide population estimates. This paper presents the modeling procedures used to simulate the near-source and far-field impacts of gas and reactive air toxics and the evaluation of the hybrid air toxics modeling system for benzene, 1,3-butadiene, formaldehyde, acetaldehyde, chloroform, trichloroethylene and diesel particulate.

**INTRODUCTION**  
Exposure to air toxics and associated risk is an increasing concern in urban areas across the United States (US) as well as globally for some compounds. Urban air toxics include compounds that have been traditionally associated with gasoline and diesel combustion (mobile sources), such as diesel particulate, benzene, 1,3-butadiene, formaldehyde, and acetaldehyde, as well as compounds associated with other industrial sources, such as carbon tetrachloride and hexachloro cyclopentadiene and heavy metals (e.g., mercury and cadmium). The US Environmental Protection Agency (EPA) has several programs underway to assess exposure to air toxics and to develop mitigation strategies. The evaluation of alternative control strategies for air toxics is performed using air quality modeling.

Currently EPA recommends the use of the ISC air quality model to assess the impacts of urban air toxic compounds. ISC is a steady-state Gaussian plume model that treats transport and dispersion assuming instantaneous dilution of pollutants from the source to the receptor and treats chemistry through a constant half-life decay rate. However, such a modeling approach has several limitations for simulating air toxics:

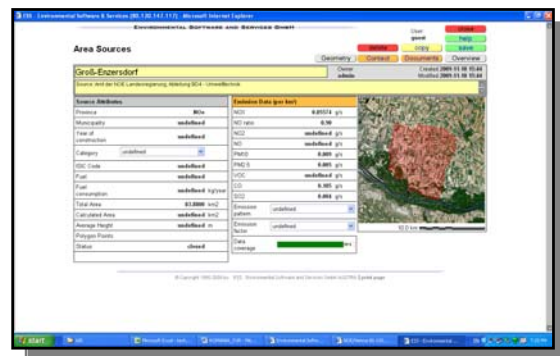
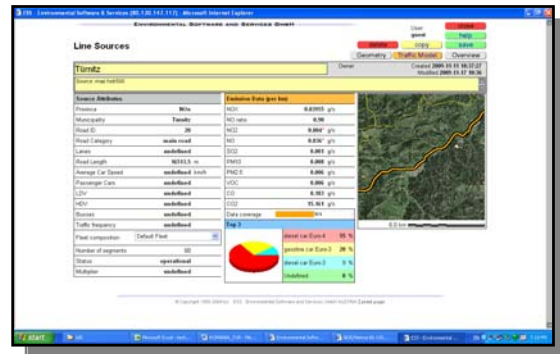
Both models must support point-type sources for emissions; it would be a plus if they allow line and surface sources.

All models in AirWare **support point, area, and line source objects** (and optional volume sources) in the **emission data base** (inventory and emission scenarios) that are automatically processed for optimal resolution model use.

The emission data base supports:

- industrial plants that combine large point (boilers and stacks) and area (fugitive) emissions
- boilers and stacks (possibly grouped into industrial plants)
- small stacks (commercial, residential)
- complex area sources (with a set of contributing activities or industrial sector, e.g., EMEP emission inventory)
- area sources
- line sources (polylines)

For a given area (domain) the emission sources are grouped into emission inventories; For each mode/domain combination, emission scenarios can be defined that also include (temporary) modification of sources and temporal emission patterns.



To easily achieve the emission limits assessment, the model should allow the introduction of both 'mass flows' and 'concentration of pollutants' present at the dispersion chimney.

The emission data base can use **both mass flux (g/s)** or volumetric flow and **concentration data**. AirWare also includes a data base of emission coefficient or emission factors, that can be used to estimate emission from activity data according to the EEA **CORINAIR** tier one methodology.

Optional extensions to tier two and three assessment methodology are available. Specific tools include statistical, rule based and AI (case based reasoning) methods for emission estimation.

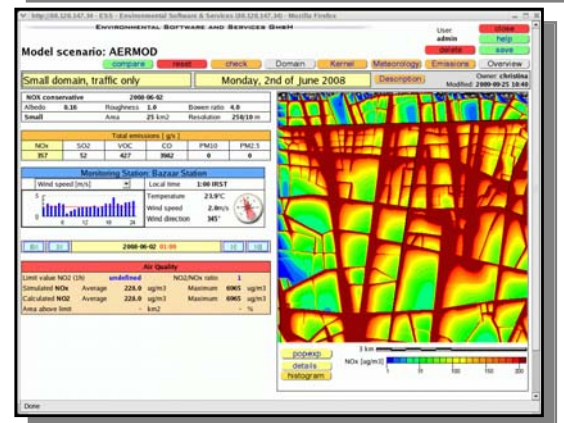


The application of dispersion modeling of emissions data should allow user the development, in a friendly manner, of the emission and modeling scenarios that underlie the best grounding decisions on setting emission limit values. In developing the modeling and emission scenarios, the application must allow complex spatial analysis and query by attributes, related to emission sources, the type (ex. point or diffuse), the positioning and characteristics of emission sources, to highlight specific geographic features of the area studied, with possible major impact (landscape, geomorphology, the use of land, protected areas, etc.) using GIS technology through the Internet.

AirWare interactive interface supports the easy **interactive generation of emission scenarios** (selection and scaling of emissions sources by class or individually); automated (scheduled) or interactive scenario runs with the input data automatically provided from the data base (meteorology, emissions) for the selected model domain and resolution, different models.

A range of display and post-processing functions including animation of dynamic maps including estimation of population exposure; and the direct comparison of scenarios for impact assessment of emission control strategies.

As an optional component, AirWare can integrate a multi-criteria **emission control optimization** module to determine cost efficient (minimum cost) emission control strategies to meet regulatory standards. The interactive, graphical and partly symbolic interface is also supported by an embedded rule-based expert system.



Population exposure post-processing

The application of dispersion modeling of emissions data should consider the following relevant pollutants in order to set emission limits:

The models integrated in AirWare can simulate **any and all substances for which emission data are provided**; this includes: buoyant gases, with and without chemistry (complex photochemistry, exponential decay, user defined reaction kinetics); particles including metals, (user defined size and gravity distribution) and air toxics (organic compounds); and include representation of wet and dry deposition and wet scavenging.

For a detailed description of CAMx chemistry options, please refer to: **CAMx R5.10 Release Notes:** [http://www.camx.com/Release\\_notes\\_v5.10.txt](http://www.camx.com/Release_notes_v5.10.txt)

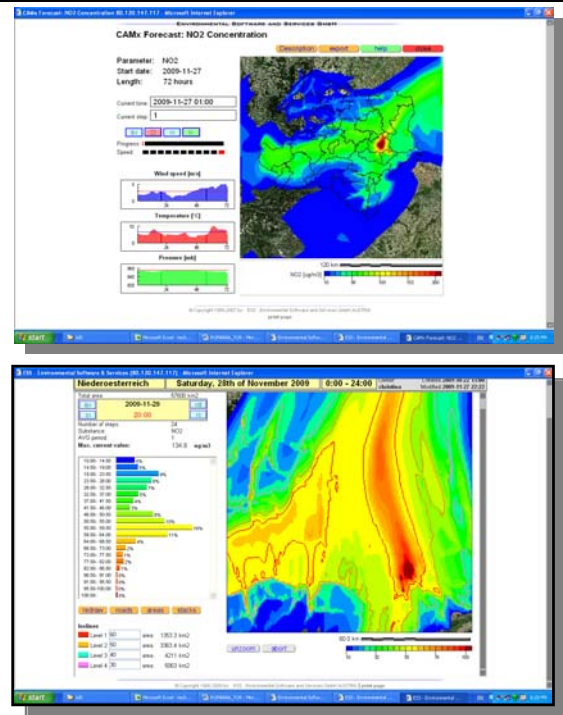


The application of dispersion modeling of emissions data will allow the generation of maps on the transport and dispersion of pollutants, with the possibility of selecting representative geographical layers and / or of interest to the user. The application will allow storage of maps and export to common formats (pdf, png, jpg, etc.)

AirWare model output is generated as (dynamic) map overlays (**topical maps**) that can be interactively controlled and configured by the user.

Options include arbitrary zooming, selecting of (stacks of) overlays, interactive color coding and choice of style (computed concentrations transparent or opaque) animation of dynamic model runs (from 24 to 2130 hours) as mpeg files for animation, including a built in player (JAVA);

Model results can be exported as images (directly from the browser interface) or as numerical values in numerical formats (tabular, CSV for local client side post-processing e.g., with ArcView, MATLAB, etc.



The application of dispersion modeling of emissions data will allow developing of complex visual reports (maps, graphs, tables) by combining the emission scenarios and modeling applied objective / area of interest

AirWare output in all its different and user configured/selected formats is provided in range of **graphical and also numerical formats**, under interactive display control for web-based browser clients.

Alternative access is by 3G high-resolution touch screen smart phones and PDAs.



The application will allow access of up to 10 simultaneous users on modeling projects and a total of up to 100 users to visualize data and existing reports.

AirWare has **NO LIMITATIONS** on the number of registered or concurrent users.

The system includes a user data base and user management system, that can be accessed and edited (user registration) by system administrators only.

ID	PRIO	LASTNAME	ACTIVE	GROUP	LAST LOGIN	LOGINS
admin	1	System Administrator	yes	ADMIN	Fri 20 Nov 2009 16:11	10
ana_admin	1	Muhammad	yes	ADMIN	Wed 10 Nov 2009 20:11	0
ana	1	Iskandar	yes	ADMIN	Thu 10 Nov 2009 02:05	0
ana2	1	Shahri	yes	ADMIN	Thu 10 Nov 2009 01:01	0
ana3	1	Wahyuni	yes	ADMIN	Thu 10 Nov 2009 01:01	0
ana4	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana5	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana6	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana7	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana8	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana9	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana10	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana11	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana12	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana13	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana14	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana15	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana16	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana17	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana18	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana19	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14
ana20	1	Chandra	yes	ADMIN	Thu 10 Nov 2009 16:11	14

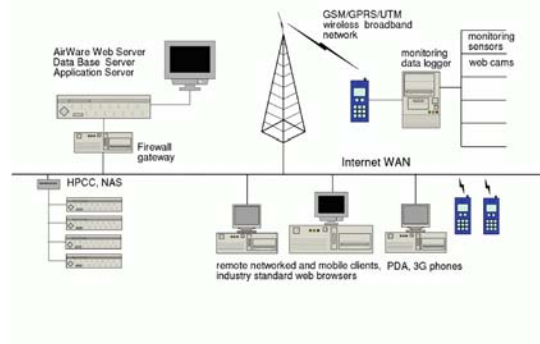
The application of dispersion modeling of emissions data will be independent, but allow communication with Oracle ODBC connection with existing software infrastructure already in ANPM (relating to Pollution Control and Risk Management Department).

AirWare operates as a distributed, modular **client-server system on Intel processors** (e.g., XEON, quad core) type servers, and is implemented under the Open Source Linux (Ubuntu) operating system.

The System uses a number of (logical) servers (minimally:

- web server,
- data base server,
- application server),

that can be implemented on one or more physical servers.



The application of dispersion modeling of emissions data will use the hardware infrastructure already existing in the ANPM:

1. Database server - Server 4-Socket, rack mountable 4U, 4 Quad-Core CPUs , 48GB RAM
2. Web server – Server 4-Socket, rack mountable 4U, 4 Quad-Core CPUs, 48GB RAM

AirWare is implemented as a distributed client-server system; a number of logical servers are implemented on one or more physical servers that communicate over a high speed local (Gigabit) backbone, or a broadband WAN solution.

The basic (logical) servers that combine into an AirWare installation are:

- Web server (Apache)
- Data base server (SQL RDBMS)
- Application server (one or more for the model executions)
- Optional: backup server
- Optional: remote or local mirror installation

The example shows a typical HPC (High-Performance Cluster Computing) installation at ESS GmbH



The application of dispersion modeling of emissions data will have to have an optimal response time for an actual action in terms of reporting and a maximum of 10 concurrent users OLTP type, considering the running time of dispersion models, processors Maps, complexity scenarios and during processing / viewing data.

To **optimize system response** and overall performance, AirWare offers both

- Fully interactive tasks (foreground computing)
- Background tasks (batch processing) that provide feedback to the user (eMail, SMS) when finished.

AirWare also includes a number of optional tools for optimal load balancing to minimize systems latency and response time and optimize calculation times for large model runs.





The application of dispersion modeling of emissions data will use web technology, all its functionality is accessible through the browser (you must detail the technology used on the application). The application will be built so that the web interface allows both viewing and editing data involved in the modeling process, commenting on existing information systems, generate reports, export and import of data needed for modeling process, all via the Internet.

AirWare is implemented as a **web-based distributed client-server system** under Open Source Linux operating system on Intel 64 bit multi-core CPUs (e.g., Ubuntu 10.x), with the application being implemented on one or more physical servers, that support an Apache web server, SQL data base server (any standards RDBMS such as ORACLE, PostgreSQL, or MySQL), and one or more application servers. Access is through any standard web browser and TCP/IP/http. The user interface and communication dialog is based on standard HTML/XML, Javascript, optional JAVA components, PHP, and cgi's implemented in C++. Client side software requirements are limited to a web browser, (optional)JVM, and standard tools (Javascript) and plugins for standard MIME formats such as animations (mpeg). All user interaction and (most) system administration is exclusively through **browser-based** web (LAN or WAN including 3G mobile phone) access.

The application will be accompanied by complete installation, operation and management manuals, in the Romanian language, delivered before the provisional acceptance.

PLEASE NOTE: AirWare manuals are available as **on-line multi-media user and reference manual** documents, fully integrated with the system, In addition, an on-line problem reporting and tracking systems with RDBMS backend is used to compile, monitor, and support all user problem and bug reports during the support and extended warranty period.

These documents can be translated from English incrementally by the local partner during the support and warranty period.



User access will be based on rights at different levels for different types of users.

AirWare offer **user defined access control** and group and “service” user privileges for different groups of users (guest, registered user, Administrators) by

- User name and password
- IP address and domain (different access for internal LAN and external WAN users)

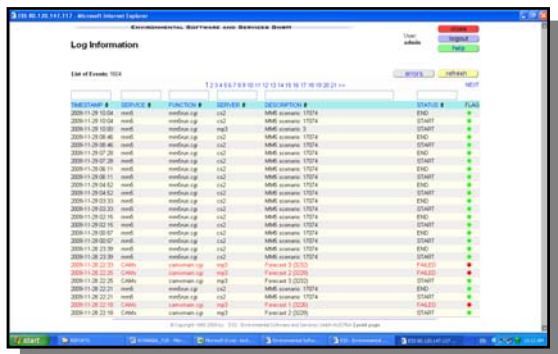
User and user access rights are controlled by the system administrator’s through the web-based user data base and configuration tool,



The system will take into account security measures for access to data and configuration, as well as for the entire database. Also, the database will have to record (in "log files") the users activity - the date, time and IP access - so that any user can view, on request, their own logins and information entered by him.

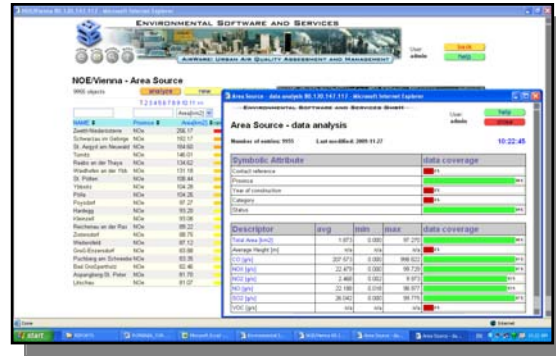
AirWare maintain **dynamic system logs** in the data base; the set of actions to be logged can be easily configured; the logs also include an error log with link to a more detailed error description for trace-back and debugging for all errors from automatic and scheduled as well as interactive model runs.

User management includes continuous log of all access (login) and execution of all major functions such as data base editing or model runs.



The application must include a search engine and reporting using different sort criteria selected by the user for their own logins

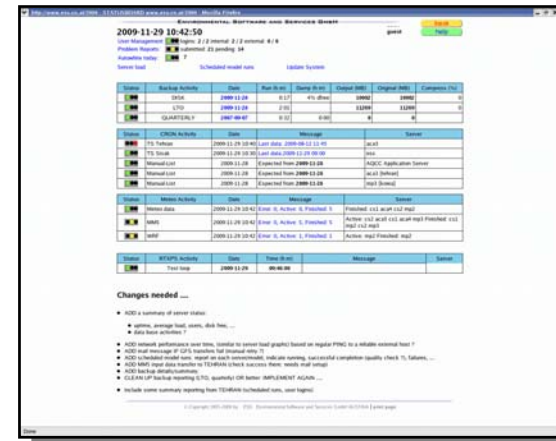
All object data bases in AirWare include a multi-criteria sorting, ranking, selection and analysis component for the easy identification and retrieval of information.  
 Direct SQL access to the industry standard RDBMS data bases support of course any arbitrary query for administrator users.



The on-line multi-media manual pages can be configured with an optional full-text search engine.

The application must allow saving data on different media (CD, DVD, HDD, other), must allow saving data on request for users with specific rights (for this type of request, there must be a security measure in the interface, on the specialist level and configuration level).

AirWare is implemented under Open Source Linux; at the operating system level, any and all files, directories or data base dumps can be saved to any device supported by the system hardware.



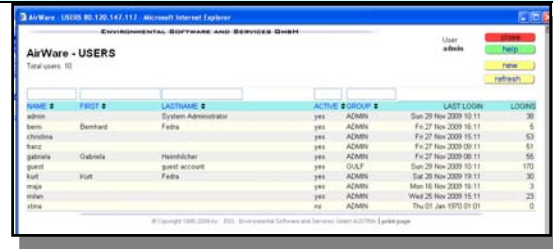
The system provides an optional automatic backup (incremental and zero level) utility for

- disk or any random access device,
- tape robots, e.g., Dell PowerVault.

The supplier will deliver 1 (one) license application, valid for a minimum of 10 concurrent users before the provisional acceptance.

AirWare is provided with an open ended, no limitation on the number of total or concurrent user users, binary, non-transferable site license.

AirWare has **no limitation** on the number of total or concurrent users. Additional user can be added to the systems and configured by the system administrator without any limitations as to their number or concurrent use.



The supplier will provide technical support for IT application of dispersion modeling of emissions over the entire warranty period (12 Month)

AirWare provides a range of remote (web based) **user support tools** for remote, web-based technical support:

- basic eMail queries (guaranteed response within 4 hours during office hours, 24 hours outside office hours)
- a web-based problem reporting and tracking system with database backend, automated mail or SMS feedback;
- web-based discussion forum;
- on-line eLearning training material (lecture notes) and interactive courses (optional) (see: <http://www.ess.co.at/TRAINING/AIR>)

