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1. Management summary

The Stockholm pilot will demonstrate the SUDPLAN Scenario Management System and its Common Services capability of air quality downscaling and how it can be coupled to existing high resolution local models. SULVF, the partner responsible for the Stockholm pilot, provides emission input and monitoring data for model evaluation. The generated model results should be presented in advanced 3D/4D visualization applications developed by the SUDPLAN project and that may require input of complementary local data (e.g. 3D maps).

This report aims at presenting the status of the pilot activities in Stockholm.

Stockholm pilot activities and use-cases have been defined in the D5.1.1 Pilot Definition Plan V1. The status of activities scheduled for the end of 2010 is as follows:

- Presenting climate scenario information on the European scale: This has not been possible as the respective user interface will only be available in April 2011.

- Air quality downscaling for historical period and a climate scenario: Relevant emission data for present conditions (2010) have been identified, revised and quality assured. Downscaling for historical periods have been performed and also validated against measurement data with satisfactory results. The downscaling of a climate scenario has not been achieved yet, awaiting European scale boundary conditions to be completed in January 2011.

- 3D map as underlay for advanced visualizations of model results: a 3D map has been achieved for a test area in central Stockholm. Some local model test data have been generated to support the design of the visualization.

The Stockholm pilot has furthermore participated in the iterative mockup process for two user interfaces of the Scenario Management System, linked to the Common Services air quality downscaling:

- Visualize air quality results

- Execute air quality downscaling

The pilot has also initiated a compilation of plans for large infrastructure projects that will influence future emissions around Stockholm. These projects will form the basis for the development of emission databases for future years, to be prepared later in 2011 and 2012.

2. Pilot objectives and activities

The Stockholm pilot will demonstrate the SUDPLAN Scenario Management System (SMS) and its Common Services (CS) capability of air quality downscaling and how it can be coupled to existing high resolution local models. SULVF provides emission input and monitoring data for model evaluation. Generated model results should use advanced 3D/4D visualization applications that may require complementary local data.

Stockholm pilot activities have been defined in Section 2.6 of the D5.1.1 Pilot Definition Plan V1 for Stockholm. The activities have been separated under three main areas, reflecting the overall role of the Stockholm pilot. The following tables 1a-c summarizes Section 2.6 in the D5.1.1 document, commenting on activities performed during 2010.

Table 1a Area 2.6.1 Using Common Services (see D5.1.1 document).

activity	***Title***	***scheduled***	***comment***
2.6.1.1	Presenting climate scenario information on the European scale.	M12	*SMS and respective user interface not available until m16, not possible before. Not initiated.*
2.6.1.2	Intense rainfall downscaling: Just demonstrating that this is possible, SULVF will hand over results to external stakeholder.	M24	*Not initiated.*
2.6.1.3a	Air quality: urban downscaling for historical period and a climate scenario, both using constant emissions.	M12	*Emission data for current conditions prepared. Two month-long historical periods simulated and evaluated. Climate scenario simulations not performed yet.*
2.6.1.3b	Air quality: urban downscaling for various climate scenarios and with time-varying emissions.	M30	*Compilation of long term project plans that may constitute the basis for future emission databases.*

Table 1b Area 2.6.2 Use of local models (see D5.1.1 document)

activity	***title***	***scheduled***	***comment***
2.6.2.1	Design of advanced visualizations including 3D city map.	M12	*3D map made available for SUDPLAN, testing on formats and use as underlay for visualizations..*
2.6.2.2	High resolution grid model simulation.	M24	*Test output generated by local 2D model (not grid model).*
2.6.2.3	Street canyon model simulations.	M24	*Test area output generated.*

Table 1c Area 2.6.3 Scenario evaluation and visualizations for urban planning (see D5.1.1 document).

activity	***title***	***scheduled***	***Comment***
2.6.3.1	Creation of different urban planning scenarios.	M24	*Compilation of long term project plans that may constitute the basis for future emission databases.*
2.6.3.2	Grid model simulations of urban planning scenarios.	M24	*Not initiated.*

The work performed according to the comments in table above are described here in the following subsections. Work has been performed by the following persons:

Partner	Person	Role
SULVF	Christer Johansson	end user representative, expert on local data
SMHI	Magnuz Engardt	MATCH model incl. high resolution grid model, climate scenarios
	Stefan Andersson	street canyon modelling, model evaluation, documentation
	Lars Gidhagen	urban modelling, user interface/ mockups
Apertum	Lars Örtegren	expert on model system integration, user interface, visualization,linking SMS to CS and local model applications

2.1. Air quality: urban downscaling for historical period and a climate scenario

The Common Services module for air quality downscaling is operational as a prototype and has been tested against monitored (measured) values for historical periods, briefly documented in D4.4.1 Air Quality Downscaling Service V1. The full demonstration of the air quality downscaling through the SMS user interface will be documented in D5.2.2 Stockholm Pilot report V2, planned for August 31, 2011.

The present Stockholm Pilot report V1 will focus on the preparatory work to produce model input data (emissions) and monitor data for model evaluation, together with a first round of model evaluation of NO_2 and O_3 for historical periods. Model evaluation of PM10 has been initiated and will be completed early 2011.

The technical demonstration of a long term air quality downscaling climate scenario simulation for the Stockholm area has not yet been achieved, but will be ready during the first months of 2011. The urban downscaling simulations will have access to new and improved simulations of European scale air quality within a changed climate that just are being completed (January 2011). The first two scenarios are based on regional climate model (SMHI's RCA model) downscaling of two global models HADLEY A1B and ECHAM5 A1B for the period 1961-2100, where the air quality simulation uses time-varying RCP 4.5 emissions.

In addition, there has been preparatory work performed for the local model implementation and enhanced visualization (3D map).

2.1.1 Emission data

The SUDPLAN downscaling require consistent emissions of 6 species, while the existing emission database of the SULVF air quality management system has so far been used for simpler models which disperse only one, inert pollutant at a time. As SUDPLAN scenario modelling will be used to forecast air quality changes various decades ahead, there must be work performed to find the plans for how the Stockholm region will expand and change its infrastructure. New urbanizations, more inhabitants and roads mean new emissions to the atmosphere.

2.1.1.1 Preparation of a SUDPLAN database for present emissions

The Common Services air quality downscaling model uses emission data stored in Airviro databases, operationally updated by the SULVF technical operator SLB (Stockholm municipality), for reporting purposes and for use as input to SULVFs local models. SUDPLAN activities include the identification of an emission database that can deliver all relevant emissions species required by the CS downscaling CTM model as well as by the local street canyon model (since results will later be coupled). Such a database, valid for 2010, was identified, revised and quality assured.

2.1.1.2 Description of SULVF emission inventories and its management (external work)

This section describes the way SULVF manages the emissions within the Stockholm region.

2.1.1.2.1. General overview of the emission database

A detailed emission data base for the Stockholm region is managed and updated on an annual basis by SULVF. The database covers 6 counties in Sweden (300 km x 400 km) with around 3.5 million people (36 municipalities; about 40% of the total population of Sweden). The largest point sources are introduced in the model as individual stacks while smaller point sources, together with areal and traffic sources are collected on an emission grid. The database includes tables for temporal variations of the different sources, so that hourly emissions of sulphur (SOx) and nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC), ammonia (NH3) and particles (PM10) are fed into the MATCH-Stockholm model. The emission inventory also contains many other compounds, e.g. gases that are important for the impacts on the global climate.

2.1.1.2.2. Transport sector most important source for air pollutants

In Stockholm, road transport (both vehicle exhaust particles and suspension of road dust) is the dominating source of primary particulate matter and the vehicle exhaust is the main source of many gaseous compounds. The geographical variability in the total emissions of NOx, CO2, SO_2 and PM10 is illustrated in Fig. 1. The database contains a detailed inventory of fleet composition and number of vehicles on different streets. Road traffic emissions are described using emission factors for different vehicles and road types as given by the Assessment and Reliability of Transport Emission Models and Inventory Systems (ARTEMIS; http://www.trl.co.uk/artemis/),

that has been adapted for the vehicle fleet in Stockholm. The emissions from the ferries between Sweden and Finland can clearly be seen in Fig. 1 below.

2.1.1.2.3. Spatial and temporal distribution of the emissions

The spatial resolution in the emission database is higher than in the dispersion calculations, but there are several uncertainties in the emission data that need to be considered when comparing the results of model calculations with measurements. Currently the emissions of PM10 due to road dust suspension does not consider the real time meteorological influence on street wetness, which is an important process controlling hourly and daily emissions of PM10 from road traffic. Road dust emissions are parameterized as a function of the month to provide correct emissions on a seasonal and annual basis, but not when looking at hour to hour or day to day variations. Some sources are not included in the dispersion modeling due to lack of information on their geographical and temporal variations, e g emissions due to off-road machinery.

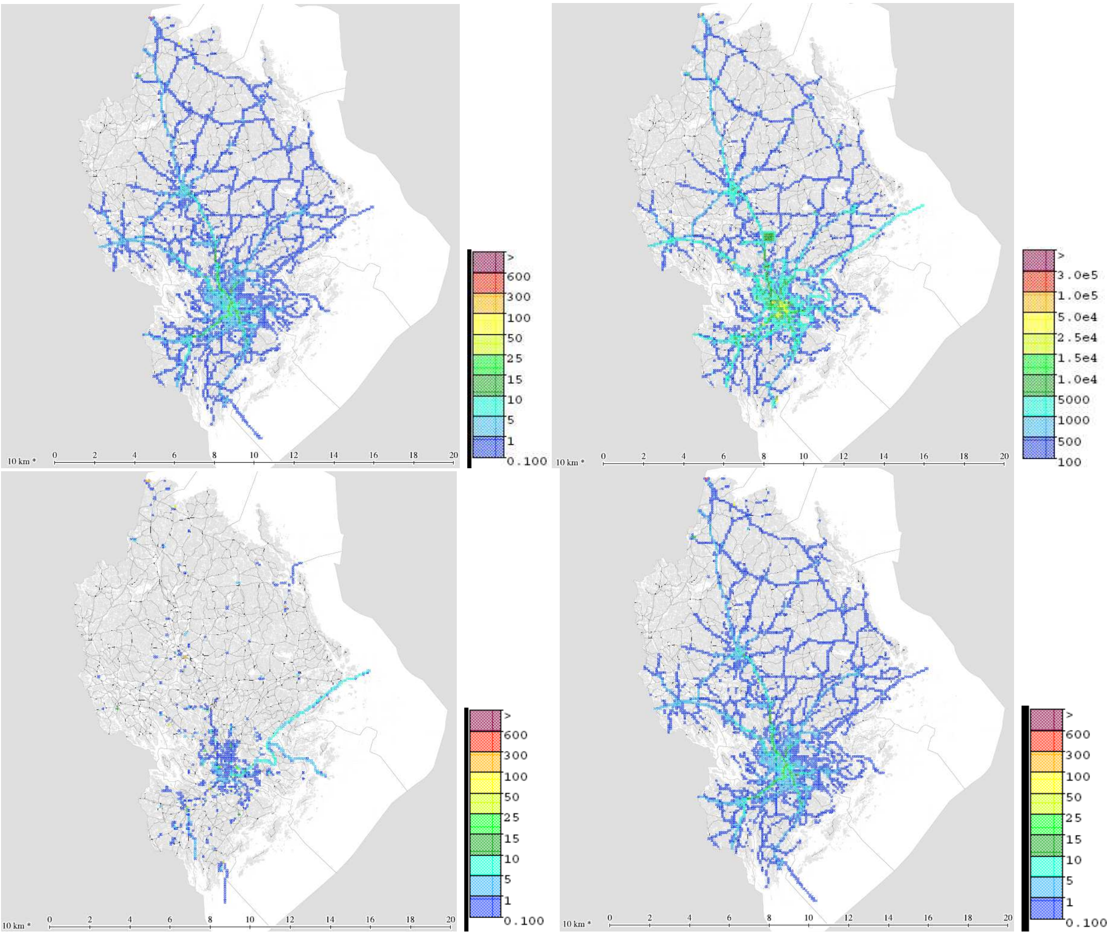


Fig. 1 Annual emissions of NOx, CO2, SO_2 and PM10 in the SULVF emission data base .

2.1.1.3 Compilation of plans for long term projects in preparation of future emission databases

Stockholm's "Vision 2030" (Fig. 2) for sustainable growth and development, outlines future plans for infrastructure and new housing and workplace areas (http://international.stockholm.se/Future-Stockholm/).

Fig. 2 Infrastructure and housing projects in Stockholm's Vision 2030.

It includes a new motorway tunnel (Bypass Stockholm – one of the world's largest road tunnel projects (21 km long. 17 km of which is in a tunnels[1]), which will have important consequences for the total transportation in the area. The emission database contains vehicle fleet emission scenarios for 2030 that, together with prognoses for the increased road traffic transports and changes energy production, can be used to estimate future emissions. Future population exposure

[1] http://www.vv.se/Andra-sprak/English-engelska/Road-construction-projects/E4E20-European-Highway-The-Stockholm-bypass-Forbifart-Stockholm/

concentrations in different climate scenarios will be estimated and visualized with the new tools developed in SUDPLAN.

The different projects of Fig. 2 constitute the basis for the development of future (2020 up to 2050 and beyond) Airviro emission databases, to be prepared in 2011 and 2012.

2.1.2 Observational data for model evaluation

An important part of any model development is to quantify the uncertainties in the calculations. For air pollution dispersion modeling the overall uncertainty of the results is best quantified by comparing with measurements, in line with the instruction given by Annex 1 of the EUs AQ Directive. SULVF manage an extensive network with real-time, continuous measurements of air pollution and meteorology. Operator is ***SLB analys***, a department at the Environment and Health Administration in Stockholm. The network started in 1993, but has undergone substantial changes during the years. Data on air pollution are provided to the public and decision makers in real time (updated hourly) and annual reports on the internet. Forecasts of air pollution based on these data and model calculations are presented in newspapers and radio.

2.1.2.1 Monitoringing stations for model evaluation

Two monitoring stations have been identified for model validation in this project (see Fig. 3). One station is located in a rural area where long-range transported pollution makes the main contribution. One is located in the city center of Stockholm, a so called urban background station, where local sources contribute significantly to the concentrations. In this way the uncertainty of the impact of local and non-local sources on the concentrations can be assessed separately. At both stations hourly mean values of NOx (NO and NO_2), O_3, PM10 and PM2,5 is recorded continuously during the whole year. All data is transferred automatically to a central database, securely stored and continuously going through a quality control procedure. Calibration is performed automatically. The rural background station is located at Norr Malma, some 70 km northeast of Stockholm centre. This is an open agricultural area without any important traffic or other sources within ca 15 km. The urban background site (Torkel Knutssonsg) is located in the city centre of Stockholm. This site is also a central location for the larger metropolitan region which includes several municipalities with about 1,4 million people.

Fig. 3 The measurement network of SULVF

There are several reasons for using NOx, PM10 and O_3 for model validation. NO_2 (the main NOx component) and PM10 concentrations exceed the limit values at traffic sites, making the control of these substances obligatory. Particulate matter is regarded the most important substance from a health point of view. O_3 is also important both for the health and the environment. Both for PM10 and O_3, long-range transport is a very important contribution motivating the need for a coupled model system going from the European scale down to a local scale.

2.1.2.2 Trends in air pollution levels in Stockholm

The SULVF measurement database can be used to show the historical trends for major air pollutants. The trends in the concentrations of Fig. 4a-c show that Urban background concentrations of NO_2 have decreased substantially during the last 2 decades. For PM10 there are less historical data available, but it seems that there is a decreasing trend of the concentrations at both the rural and urban background sites during the last 3 years. For the urban background, this may partly be due to the meteorological situation, but decreased emissions of particle precursor substances throughout Europe have likely contributed to the decreased concentrations at both sites.

Fig. 4a-c shows trends in observed annual mean concentrations, PM10 and O_3 at the monitoring stations of SULVF at Torkel Knutssonsg and Norra Malma (the black lines are from the urban background site at Torkel Knutssonsg and blue line is from the rural site at Norra Malma).

Fig. 4a

Trends in observed annual mean concentrations of NO_2

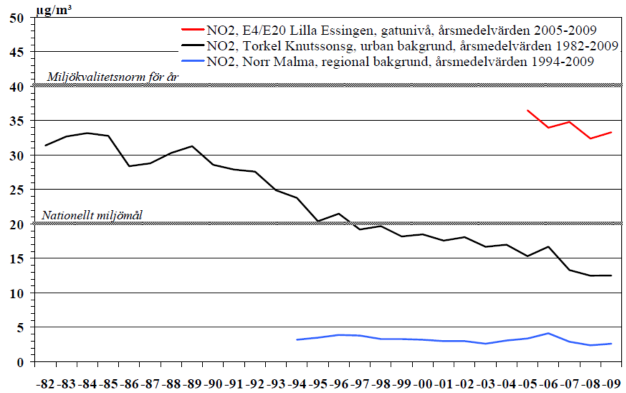


Fig. 4b

PM10 at the monitoring stations of SULVF

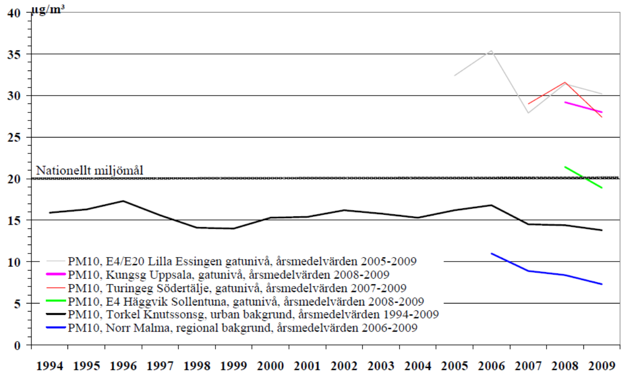


Fig. 4c

O_3 at the monitoring stations of SULVF

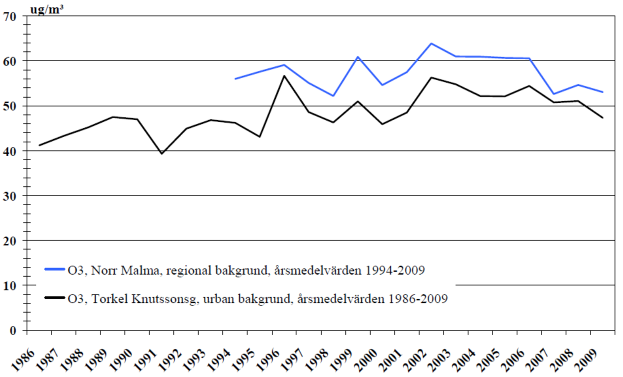


Fig. 4 Observed data at monitoring stations

2.1.2.3 Where does air pollution reach critical levels?

As stated above the air quality limit values for PM10 and NO_2 are exceeded at traffic sites (see Fig. 5). In order to predict concentrations at these streets it is necessary to use local street canyon models as part of area 2.6.2 of SUDPLAN. Several streets in the central city of Stockholm have buildings on both sides, making the ventilation poor. This problem could be much better visualized, using the 3D building geometries and visualization tools being developed in SUDPLAN.

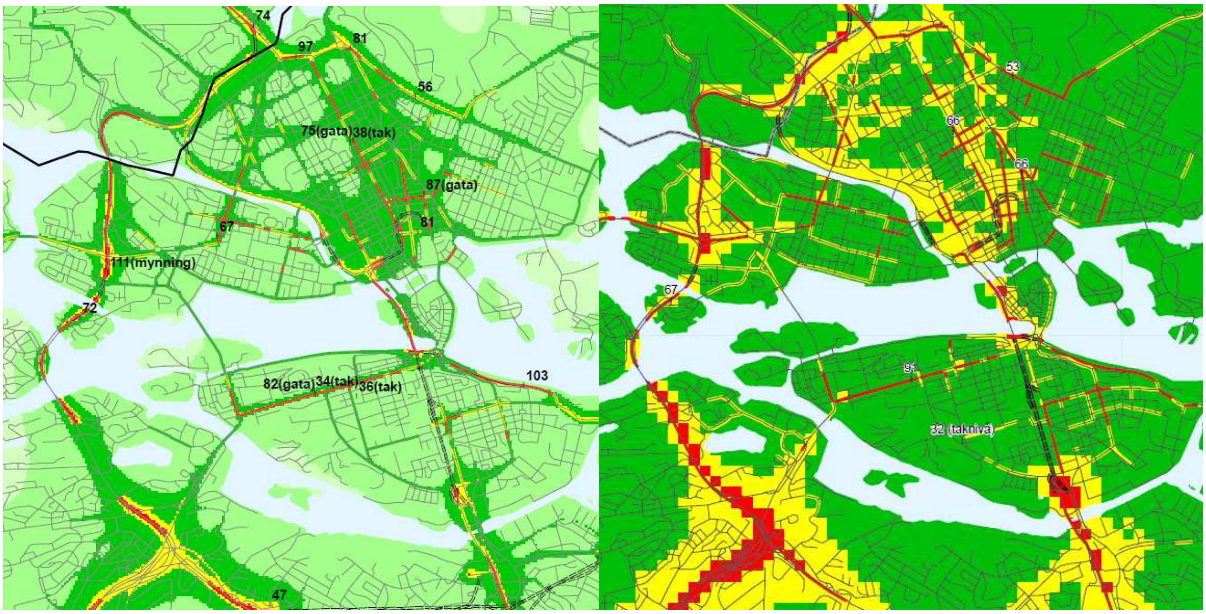


Fig. 5 Modelled concentrations of NO_2 (left) and PM10

Fig. 5 shows modelled concentrations of NO_2 (left) and PM10 in Stockholm in relation to the limit values. Red colours indicate areas where the limit values are exceeded. Numbers in black are measured values in $\mu g/m^3$.

2.1.3 Model evaluation for a historical period

The SUDPLAN downscaling model has been executed for two month-long periods in 2010 and an evaluation of those results is documented here below. The model evaluation work has also been supported by the GASLINK project which ended November 30, 2010 and which used the same model approach as SUDPLAN, although with a focus on short-term air quality forecasts. Parts of the GASLINK results conclusions are presented separately here below.

2.1.3.1 SUDPLAN evaluation of NO_2 and O_3 for two month-long periods

The SUDPLAN evaluation to be presented here was made with MATCH-HIRLAM European scale model application contributing to boundary conditions for the urban downscaling MATCH-Stockholm application. The evaluation includes two month-long downscaling simulations of NO_2 and O_3. The Model output is compared to monitored data at the urban background station Torkel Knutsson in Stockholm.

Downscaling of NO_2 and O_3 has been run for two periods, January 01-31, 2010 simulated on a 102x102 km grid with 2x2 km spatial resolution, and October 17-November 16, 2010 simulated on a 100x100 km grid with 1x1 km resolution. Statistics relevant for evaluation of EU air quality standards are given in Table 2a (for NO_2) and Table 2b (for O_3).

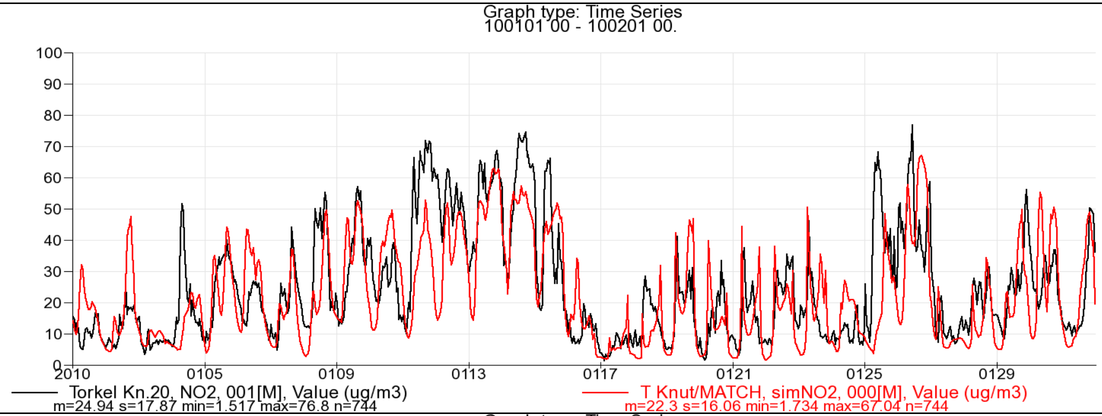
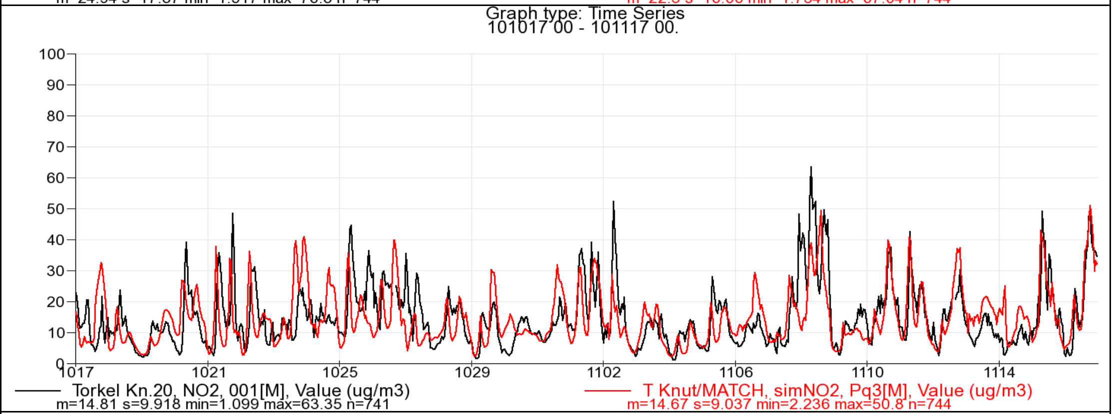
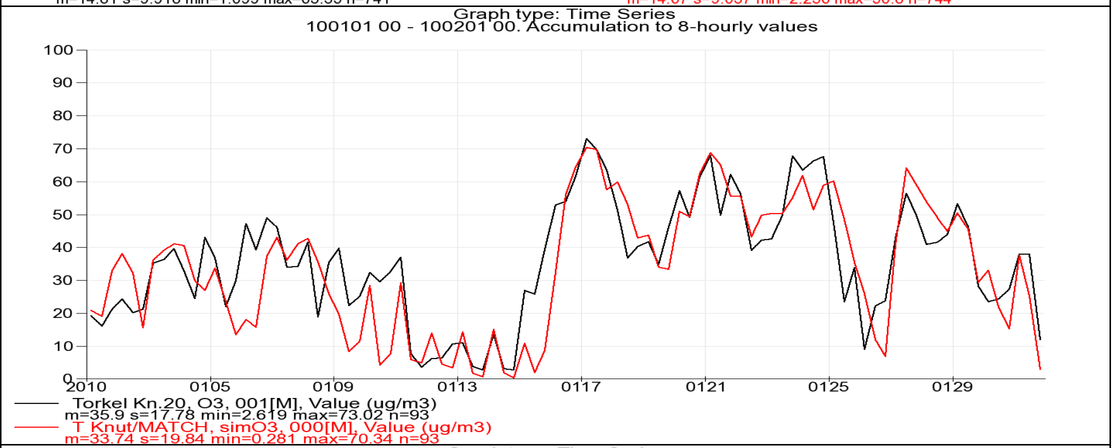
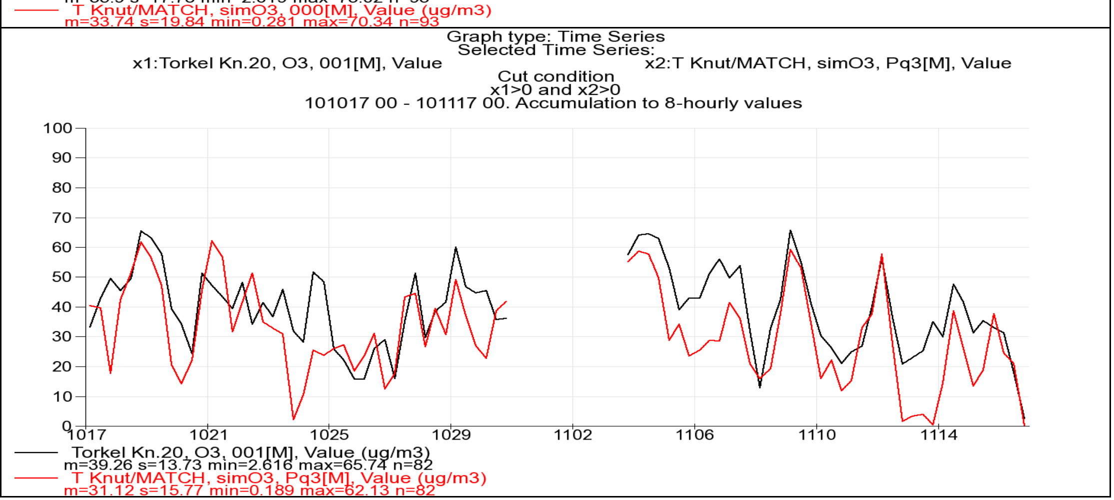
Table 2a Comparison of simulated and monitored NO_2 at urban background station Torkel Knutsson.

		January 01-31, 2010		*October 17 – November 17,2010*	
Type of value	***Time averaging***	***Model***	***Measured***	***Model***	***Measured***
Average	Monthly mean	22.3	24.9	14.7	14.8
98-percentile	Daily means	47	56	23	36
98-percentile	Hourly means	61	67	40	46

Table 2b Comparison of simulated and monitored O_3 at urban background station Torkel Knutsson.

		January 01-31, 2010		*October 17 – November 17,2010*	
Type of value	***Time averaging***	***Model***	***Measured***	***Model***	***Measured***
Average	Monthly mean	33.7	35.9	31.1	39.3
98-percentile	8-hour means	69	69	61	65

The corresponding time series for NO_2 (hourly data) are given in Fig. 6a-b and for O_3 (8h averages) in Fig. 6c-d.

Fig. 6a NO_2 (hourly) January 01-31, 2010 Model (red), monitor (black)	
Fig. 6b NO_2 (hourly) Oct 17 – Nov 17, 2010 Model (red), monitor (black)	
Fig. 6c O_3 (8h averages) January 01-31, 2010 Model (red), monitor (black)	
Fig. 6d O_3 (8h averages) Oct 17 – Nov 17, 2010 Model (red), monitor (black)	

⇒ The results of these two month comparisons show a reasonable co-variation between simulated and monitored concentrations. Episodes with higher and lower concentrations during various days is captured by the model, as are the within-day variations of NO_2 levels. For NO_2 the highest peaks are somewhat underpredicted by the model. For O_3 the model shows too low minimum values, while the high peaks are better simulated. The spatial resolution – 2x2 km or 1x1 grid resolution - does not seem to critical.

⇒ The general impression is that the downscaling of NO_2 and O_3 is sufficiently close to monitored values, i.e. SUDPLAN downscaling of different scenarios are meaningful to compare for urban background concentrations of NO_2 and O_3.

⇒ An evaluation of simulated PM10 has been initiated and will be completed early 2011.

2.1.3.2 GASLINK evaluation of alternative European scale boundary conditions for NO2 and O3 (external work)

The GASLINK project, funded by the Swedish National Space Board, has run during two years and was formally ended November 30, 2010 (Engardt el al., 2010). The contribution of most interest for SUDPLAN is that GASLINK compared two different MATCH model applications to generate the European scale results used as boundary conditions to the MATCH-Stockholm model setup. The two different MATCH model applications evaluated by GASLINK are:

- MATCH-HIRLAM, executed on NSC super computer center in Linköping, operating with climatological boundaries varying with season. Emissions are taken from EMEP.
- MATCH-MACC is executed at ECMWF using meteorological data from ECMWF and emission data provided by TNO, Netherlands. Boundary conditions are taken from a global chemical transport model that includes data assimilation of meteorological parameters and chemical composition. The other six regional models participating in MACC use the same input data.

From the GASLINK report (Engardt et al., 2010) we cite the main results for the comparison of using different MATCH applications for the European scale boundary values to the downscaling area of Stockholm. Fig. 7 shows the spatial averages for the October 17 – November 17, 2010 period.

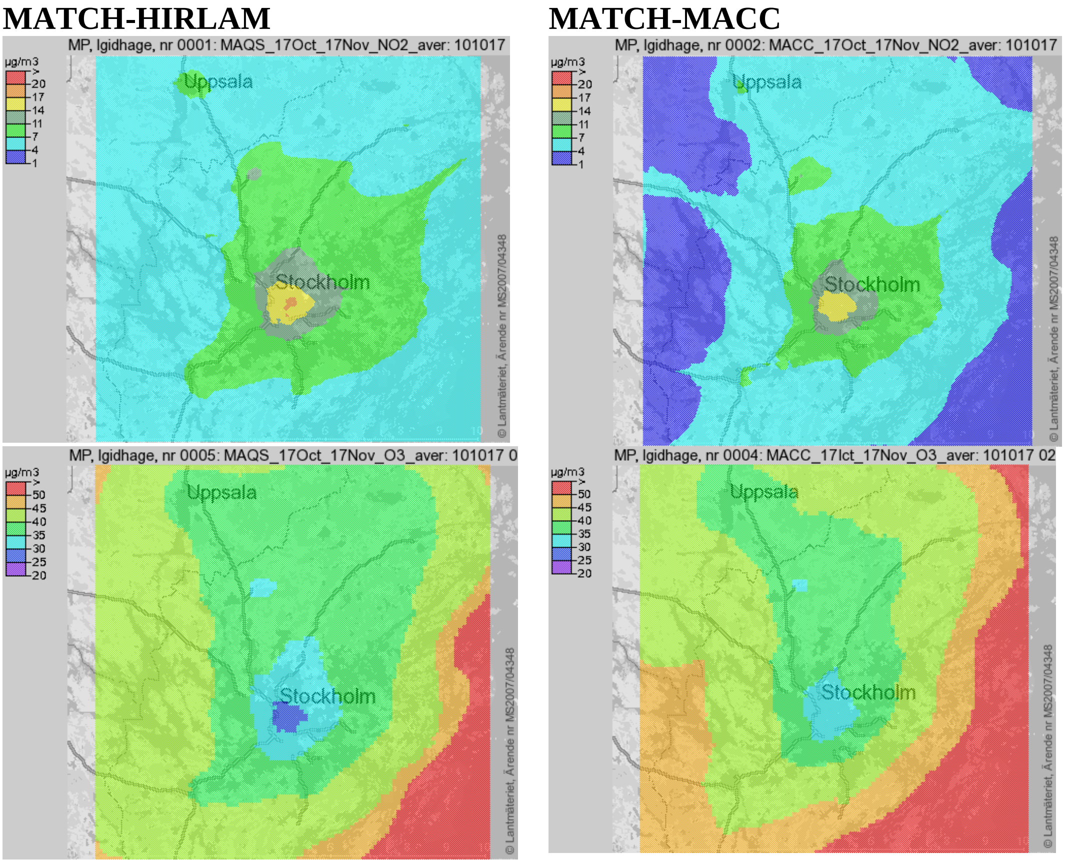


Fig. 7 Monthly averaged NO_2 (top) and O_3 (bottom) concentrations for the period October 17 – November 17, 2010.

⇒ For NO2 the two alternatives for boundary conditions yield a similar distribution, however the MATCH-HIRLAM application (used in the SUDPLAN time series evaluation) gives somewhat higher background values. As model NO_2 average (Table 2a) is very close to monitored NO_2 for this period, there are reasons to believe that MATCH-HIRLAM gives somewhat better boundary conditions for NO_2.

⇒ Also for the ozone the distributions are rather similar, but here with a tendency in the opposite direction, the MATCH-HIRLAM gives lower ozone levels than the MATCH-MACC application. According to the comparison with monitored values in Table 2b MATCH-HIRLAM contributes to too low downscaled average O_3 levels. However, the higher ozone peaks, of more relevance from a health point of view, are much better simulated. It is thus the too low ozone minimum vales that contributes to the bias of the long term average value.

⇒ Given the results so far, it seems relevant to use the MATCH-HIRLAM application to generate the European scale air quality results for historical periods. The preference between MATCH-HIRLAM or MATCH-MACC for the European scale simulations will however depend on the results of the on-going model evaluation for PM10.

2.2. 3D city map

One of the principal goals for the Stockholm pilot is to generate advanced visualizations that will make it easier for urban planners, politicians and the public in general to understand where and why the air pollution reaches critical values. A detailed 3D city map will be an important input to the visualizations of high resolution model results.

2.2.1 3D building information

Three-dimensional information on buildings and topography exists for the Stockholm region, achieved through laser scanning. This data has been provided to the SUDPLAN consortium. The goal is to use this 3D information for better and easily understandable visualizations of simulated air quality levels in the SUDPLAN graphical interface. The Stockholm pilot has worked with GIS software to understand the characteristics of the data and how they can be used in support to air quality visualizations. A test area covering a part of central Stockholm has been defined.

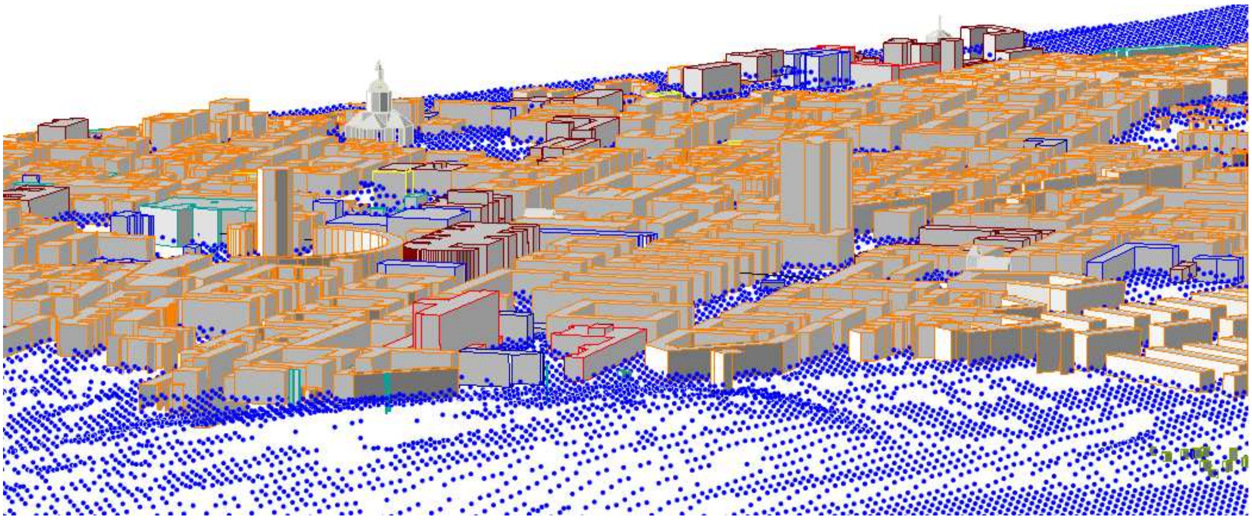


Fig. 8 Building blocks with roof height and a raster showing the surrounding terrain elevations. Example from Södermalm.

Fig. 8 shows a view over the test area, a densely populated island in the centre of the city (Södermalm). Most of the buildings are represented by cubes, neglecting roof details. Some of the more prominent buildings, like the church in the upper left part of Fig. 8, have a more detailed structure. The presentation of individual buildings and their form makes it easier for people residing in the city to orientate. The height of the houses will also help to identify "*hot spots*" with street canyon effects where street level pollution is likely to be high.

The blue dots in Fig. 8 represent terrain elevation data in a 10 m grid. With a triangular irregular network (TIN) it is possible to have vision of the surrounding topography (Fig. 9). The Stockholm 3D maps even show individual trees (not displayed here).

Fig. 9 The elevation grid can represent the topography displayed with TIN technique.

2.2.2 Use of 3D city map for advanced visualization

The Stockholm pilot will use the external SIMAIR system to assess air pollution levels close to traffic. Exceedances of air quality standards do occur in traffic environments, in particular in street canyons.

SIMAIR outputs are concentrations at each side of a road, normally within five meters from the road (if open road environment without surrounding buildings) and at 2 m from building wall in case of a street canyon environment. Model results, as annual means or percentiles, can be exported in shape format. Fig. 10 shows SIMAIR roads located together with the 3D building information. The green lines representing road links may be coloured according to simulated concentrations.

Fig. 10 Road links with simulated air pollution concentrations from the SIMAIR model system shown as green lines together with 3D building information.

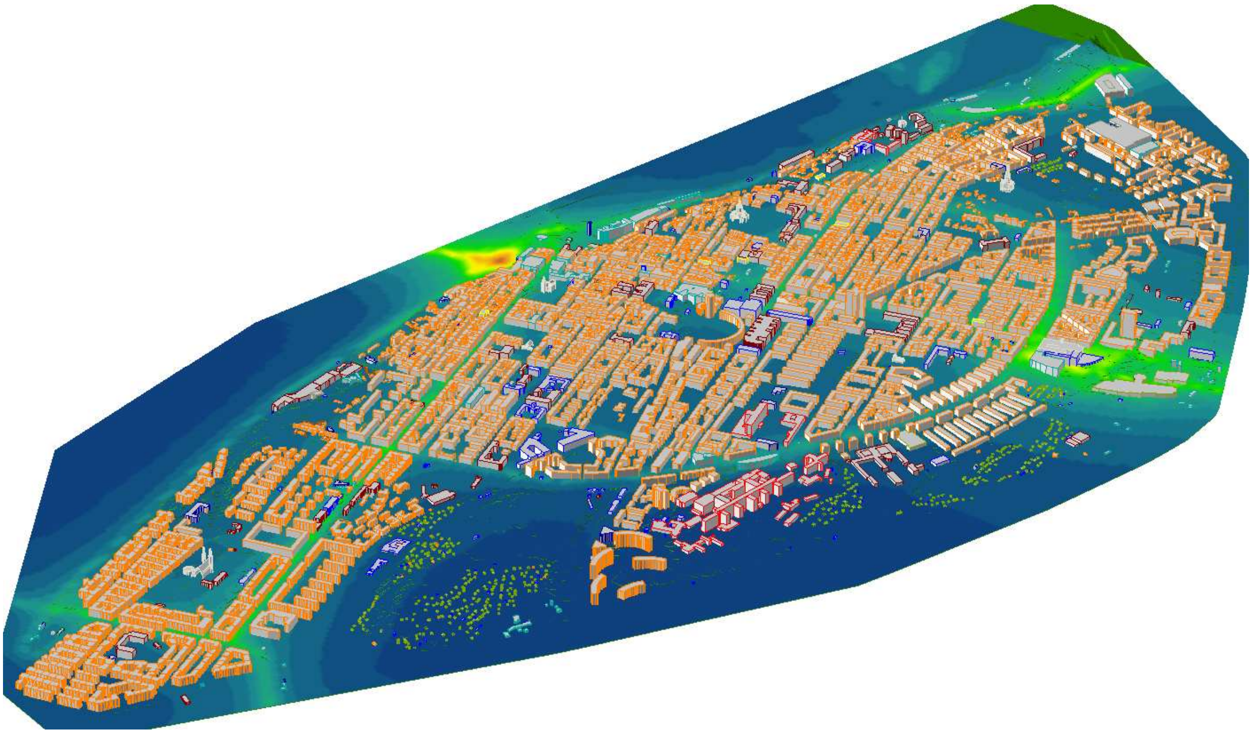


Fig. 11 Model 2Dgrid output (10x10 m resolution) overlayed the 3D city map. Hot spots like tunnel entrances and the more trafficked streets are easily identified with the given references to city infrastructure.

The small-scale SIMAIR results will be complemented by area covering model simulations from a 3D grid model (the same model as in the CS downscaling, but here used on a much higher spatial resolution). The high resolution MATCH model simulation will represent air pollution concentrations at building roof level. The Stockholm pilot visualization aims at a combination of these two types of model output, visualized in the 3D city map. During the testing of the visualization, we have worked with a model 2D output from a Gaussian model that forms part of the SULVF ordinary air quality system. The 2D model output is a grid with 10 x 10 m resolution. In Fig. 11 the air pollution is overlayed the 3D map, however still not at roof level.

Although the visualization is not perfect, Fig. 11 clearly shows the potential of improved visualizations in air pollution assessments. Higher pollution levels are easily identified in certain street canyons with dense traffic, as are the *hot spots* created outside road tunnels where polluted air is pushed out by vehicle movements.

3. Pilot Design

The Stockholm Pilot has participated in the elaboration of SMS mockups that responds to two use-cases. Starting point for both use-cases was a powerpoint by SMHI presented on a project meeting in Saarbrucken, Germany, March 17-19, 2010.

With the mockups on the blog, we could step by step suggest improvements of the user interface which the IT partners materialized in subsequent mockups. The work performed on the use-cases and the mockup results are documented in the following two subsections.

3.1. Visualize air quality model results

The visualization of European scale air quality data and downscaled city-scale data are, for the end-user, will appear to be very similar. It will be possible to visualize spatial data – gridded concentrations – and to examine time series of data from a specific point in space. The use-case UC-511 “Visualize air quality results” of the Stockholm pilot covers both these scales and also the pilot-specific application of very high resolution modelling over a part of the city.

From the ICT point of view there will however be differences. On the European scale the presentation of air pollution will go through a WMS application, while the downscaled city-scale results will be displayed as grid data over a map. The blog work detailed here has focused on the European scale presentation.

On the European scale SUDPLAN SMS will allow both spatial (gridded) fields and pointwise time series of air quality data to be displayed, according the following table. Gridded fields will always be 10-year averages while output of time series will have either year or month as temporal resolution.

Table 3 Summary of Common Services air quality downscaling results to be visualized

	Spatial data			Output time series in receptor point		
Parameter	***type***	***size***	***10-year***	***year***	***month***	***day***
NO2	grid	44x44 km	O	X	X	
SO2	grid	44x44 km	O	X	X	
PM10	grid	44x44 km	O	X	X	
O3	grid	44x44 km	O	X	X	

The iterative work on the blog resulted in a mockup according to Fig. 12. The following details should be noted:

- A 2D semi-transparent air pollution field is displayed over the map, with possibilities to modify the colours.
- A slider (to the right) helps to go back and forth in time, with 10-year steps.
- After clicking at a specific location (coordinates), it will be possible to specify if yearly or monthly data should be exported as time series.

- Time series is displayed in its own window, in parallel to the European map presentation.

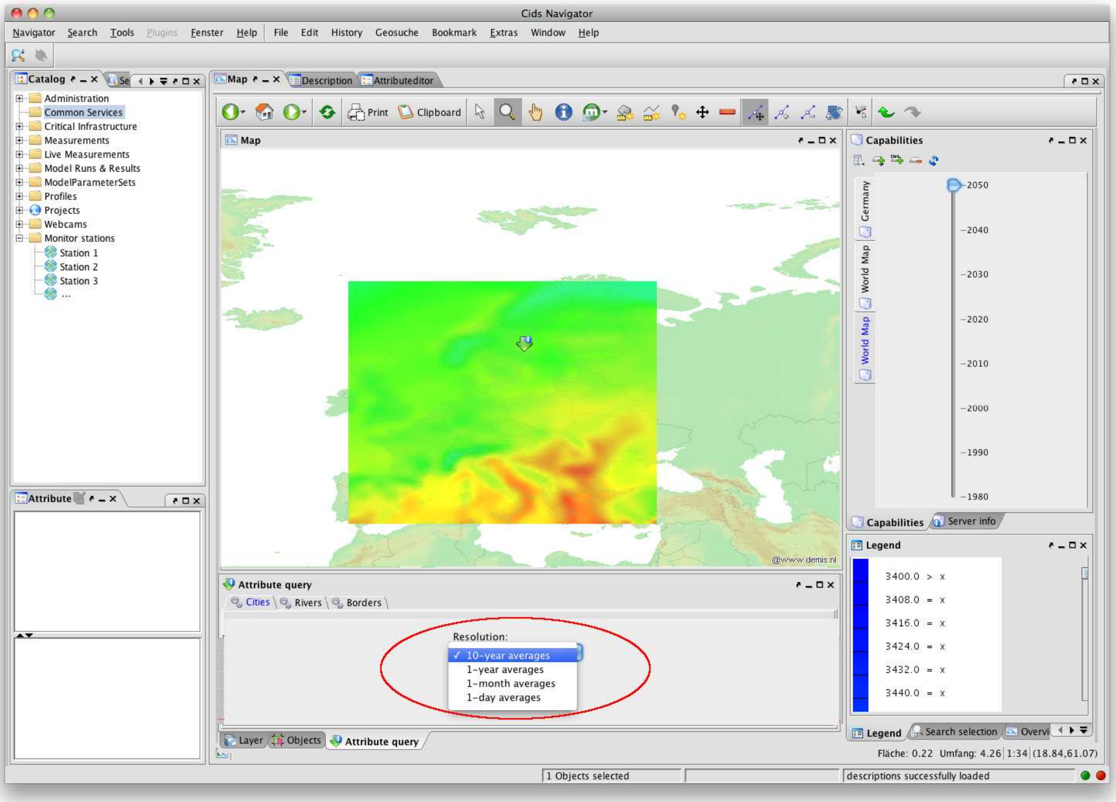


Fig. 12 Detail of a mockup for the UC-511 Visualize air quality results.

3.2. Execute air quality downscaling

The use-case UC-521 “Execute air quality downscaling” is more complex, as there are some factors that will determine the downscaling. Basically the end-user must respond to the following before hitting the “execute” button:

- Select the area of interest (simulation area of local model) in the map
- Choose grid cell size
- Choose boundary conditions (climate scenario or hindcast on European scale)
- Choose simulation period (default the same as boundary conditions)
- Define emission inventories to used and which year they represent

The interactive work on the blog resulted in the following mockup for the first two selections, those of downscaling area and grid resolution. (Fig. 13). Note that user can explicitly specify the modelling domain coordinates after the SMS suggestion, based on the selection by “mouse-click; however the simulation area must be a multiple of grid size in both x and y direction.

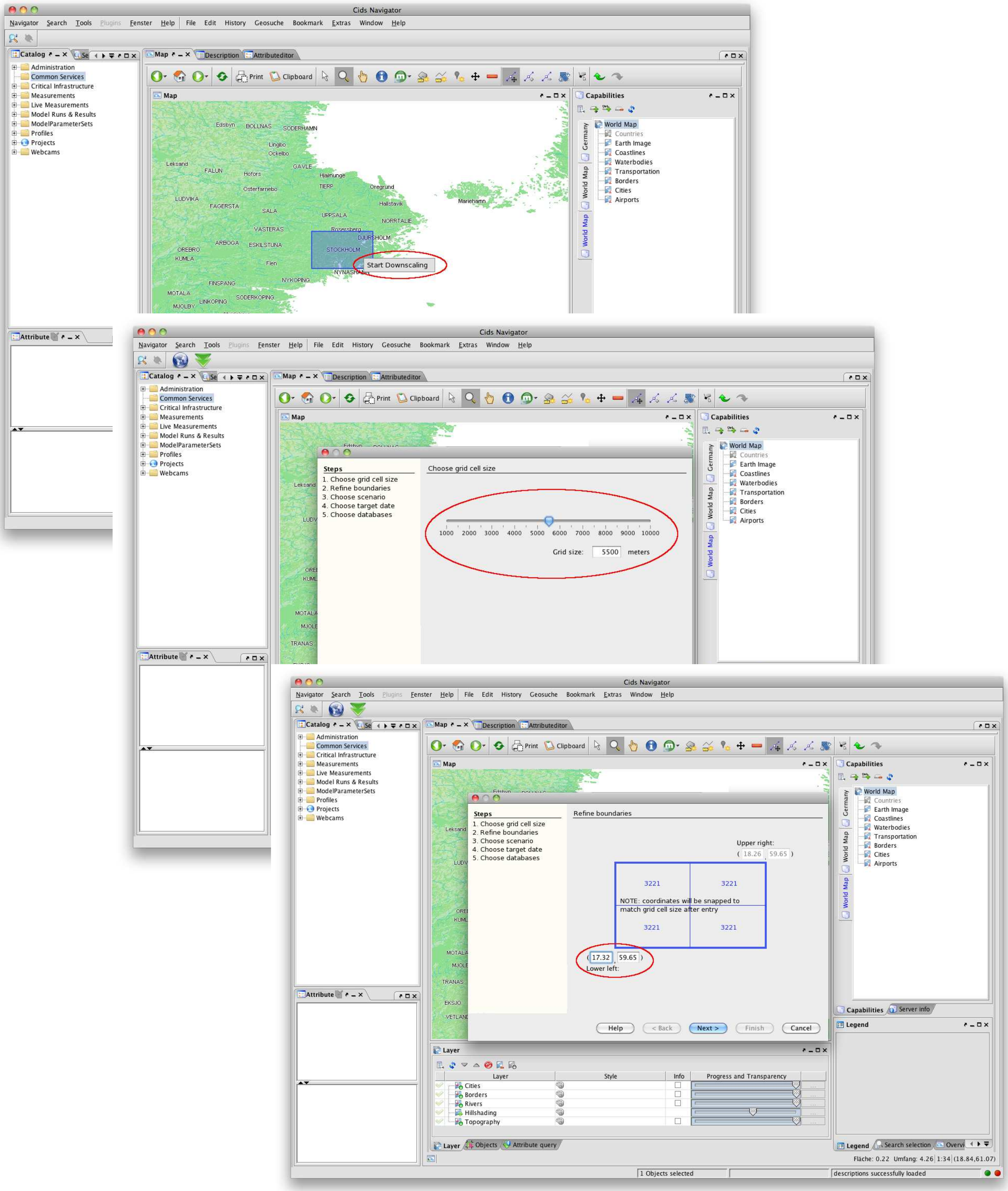


Fig. 13 Detail of a mockup for the UC-521 Execute air quality downscaling: definition of simulation area and grid resolution.

The specification of boundary conditions is simply that the SMS (client) requests a list of European scale results from the CS server and the user selects the appropriate data-set for his downscaling run. The user will also have the possibility to reduce the length of the downscaling simulation but enter “from” and “to” dates.

As for emissions the use-case assumes that there are existing emission inventories uploaded to the CS server, in Airviro format (how this upload will be made is another use-case).

Fig. 14 indicates the specification of emission databases. SMS (the client) sends a request of available emission databases. The user has to specify one of those and also indicate for which year this database is valid. If only one database is selected, emissions will be as in that database for the entire simulation.

With more than one database defined, there will be an interpolation for the years in between. Before the first "valid for" year the emissions will be as in the first database and similarly for the years after the last "valid for" year.

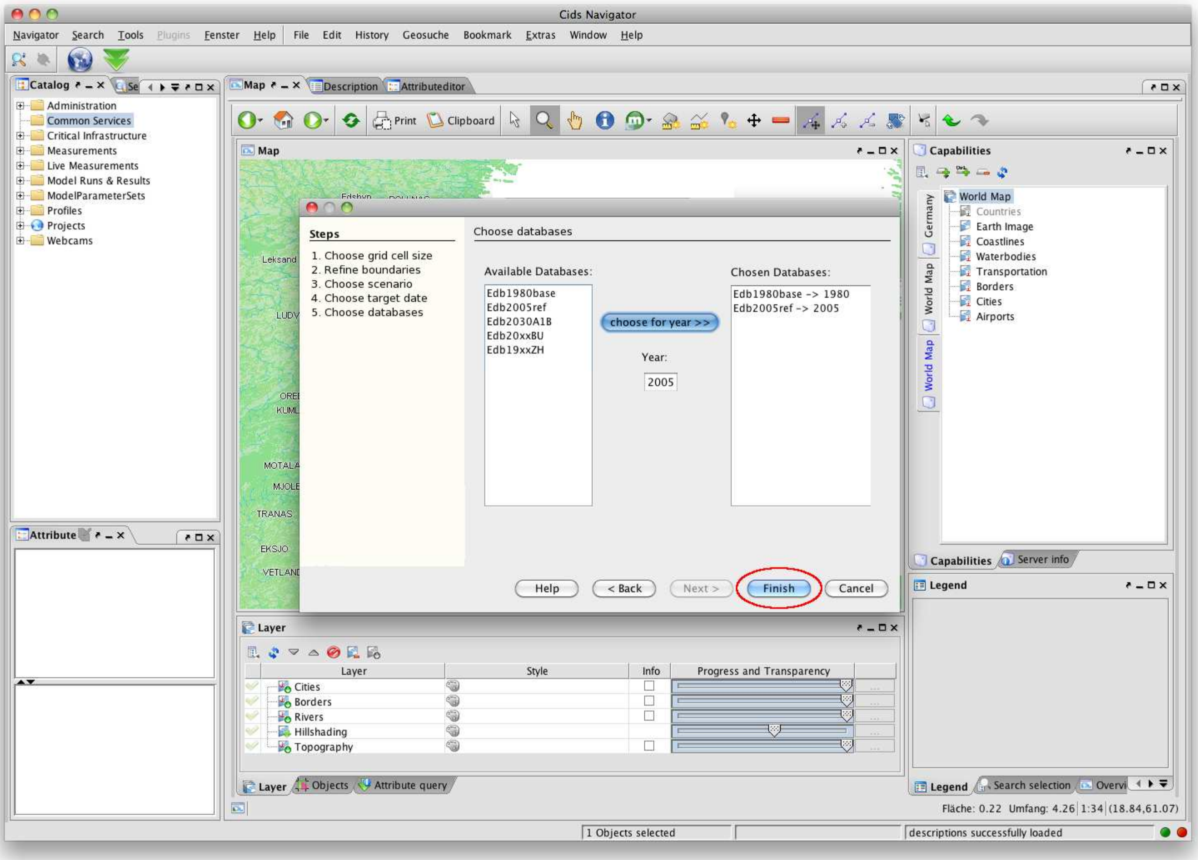


Fig. 14 Detail of a mockup for the UC-521 Execute air quality downscaling: definition of local emissions to be used.

4. Conclusions

Stockholm pilot activities and use-cases have been defined in the D5.1.1 Pilot Definition Plan V1 for Stockholm. The status of activities scheduled for the end of 2010 is as follows:

- *Presenting climate scenario information on the European scale:* This has not been possible as the integrated user interface will only be available in April 2011.

- *Air quality downscaling for historical period and a climate scenario:* Relevant emission data for present conditions (2010) have been identified, revised and quality assured. Downscaling for historical periods have been performed and also validated against measurement data with satisfactory results. The downscaling of a climate scenario has not been achieved, awaiting European scale boundary conditions to be completed in January 2011.

- *3D map as underlay for advanced visualizations of model results:* a 3D map has been achieved for a test area in central Stockholm. Some local model test data have been generated to support the design of the visualization.

The Stockholm pilot has furthermore participated in the iterative mockup process for two user interfaces of the Scenario Management System, linked to the Common Services air quality downscaling:

- Visualize air quality results

- Execute air quality downscaling

The pilot has also initiated a compilation of the plans for large infrastructure projects that will influence future emissions around Stockholm. These project plans will constitute the basis for the development of emission databases for future years, to be prepared later in 2011 and 2012.

5. References

D4.4.1 Air Quality Downscaling Service V1

D5.1.1 Stockholm Pilot Definition Plan

Engardt, M., Andersson, S., Gidhagen, L., Johansson, C., Örtegren, L. (2010). GASLINK - linking the GMES Pilot Atmospheric core Service (GAS) with the Stockholm Air Quality Service. SMHI report 30 November, 2010, available at http://www.smhi.se/polopoly_fs/1.14327!GASLINK_rapport_final.pdf

6. Glossary

technical term	*Explanation*
2D	Two-dimensional, typically a field that varies in east-west and north-south direction. The field may also vary in time –this is typical for e.g. air pollution and population density. The former varies from one hour to another while the latter maybe varies from one year to another.
3D	Three-dimensional, typically a field that varies in east-west and north-south direction as well as vertically. The field may also vary in time.
4D	Four-dimensional. Most often 3D field that explicitly also varies in time. It could also be when a certain 3D parameter (e.g. a particular air pollutant) also varies according to another 3D parameter (e.g. temperature). It will then be possible to study the variation of the first 3D parameter as a function of space (x,y,z) and the second parameter.
Airviro	Air quality management system consisting of databases, dispersion models and utilities to facilitate data collection, emission inventories etc, see http://www.Airviro.smhi.se/
Downscale	In the present context, go from courser to finer scale. I.e. employ models with higher resolution and explicit description of local processes. The downscaling models typically also utilise course resolution models (or data) as boundary conditions.
Grid model	Model that describes the atmosphere in discrete boxes (3D) or areas (2D). A grid model produces results in all grid points. The result in a particular grid point is the average value over a volume (3D) / area (2D). The shorter distance between the grid points, the higher resolution of the grid model.
Hind cast	A simulation of a historical period. Often done to compare model simulations with data which is available during that period.
Hot spot	Point (or small area) which is very different from its surroundings. In the present context, most often high concentrations of air pollutants, or extreme meteorological conditions.
Mockup	A model of a design used for demonstrating the functionality of a system.
Point source	An emission source with small spatial extent and well known localisation. Typically a chimney, or a stack.
Street canyon	Volume between high buildings in cities. Due to poor circulation (and high emissions) prone to poor air quality. Street canyons have unexpected circulation patterns, thus dedicated models are needed to study air pollution here.

7. Acronyms and Abbreviations

Acronym / abbreviation	*Definition*
A1B	Emission scenario used for global climate modelling in IPCCs Fourth Assessment Report (AR4)
CS	Common Services (SUDPLAN functionality)
CTM	Chemistry Transport Model
ECHAM5	GCM developed at Max Planck Institute for Meteorology, DE
ECMWF	European Centre for Medium-Range Weather Forecasts (http://www.ecmwf.int)
EMEP	European Monitoring and Evaluation Programme (http://www.emep.int/)
GCM	Global Climate Model
HADLEY	GCM developed at Met Office Hadley Centre, UK
HIRLAM	HIgh Resolution Limited Area Model, numerical weather prediction model developed and used operationally by SMHI
ICT	Information and Communication Technology
IPCC	The Intergovernmental Panel on Climate Change, the leading body for the assessment of climate change
MACC	Monitoring Atmospheric Composition and Climate, a SPACE FP7 project
MATCH	Multiple-scale Atmospheric Transport and Chemistry modelling system, a CTM developed and used by SMHI.
RCP4.5	Radiative Concentration Pathways: A set of four emission scenarios to be used for the AR5 simulations. The scenarios are named according to their radiative forcing at 2100, e.g. 4.5 W/m^2.
SIMAIR	An internet tool for calculation of air quality in population centres. The tool includes several different models operating on different scales and for different environments. See: www.smhi.se/en/Research/Research-departments/Air-quality/simair-model-tool-for-air-quality-1.6830
SLB analys	A unit within Stockholm city's Environment and Health Administration which is contracted for the day-to-day operation of the various air quality systems operated by SULVF, see www.slb.nu/elvf/
SMHI	Swedish Meteorological and Hydrological Institute. www.smhi.se

SMS	Scenario Management System (SUDPLAN functionality)
SULVF	Stockholm - Uppsala Air Quality Management Association. www.slb.nu/elvf/
TIN	triangular irregular network
TNO	Dutch research organization (http://www.tno.nl)
WMS	Web Map Service, a specification which comprises a definition for Internet map servers.