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1. Management summary

The objective of this Stockholm pilot report V2 is to document the pilot work on activities and tasks during the 2011 as outlined in the pilot definition plan V2 (D5.1.2). The report also documents the pilot demonstration and use of the SUDPLAN tools as defined in four use cases for the operation of the Common Services through the Scenario Management System's user interface.

Stockholm Pilot work concentrates on the scientific evaluation of downscaling results of the Air Quality Common Service. Pilot work has been grouped into a number of activities that are listed in three groups.

Using Common Services: The activity of demonstrating the use case "Visualise air quality model results" has been completed regarding the climate scenario information on the European scale. Expected evolution of climate (temperature, precipitation) and air quality (NO2, ozone and particulate matter) have been visualised for Stockholm and for two different climate scenarios.

Air quality downscaling has been made offline (using the web interface of Airviro) and the results have been compared with air pollution monitor data. Model results show good agreement with measurements, although there are some open issues in the model evaluation performed that will need further analysis during the last project year.

Use of local models: A 3D map with individual buildings has been delivered to WP3, to be used for the 3D visualisation of the Stockholm Pilot Application. Local model results have been generated with a high resolution 3D grid model and for a simpler street canyon model, both applied over the central parts of Stockholm. The Stockholm pilot has provided input on how the visualisqtion of air quality concentrations should be done.

Note, that the Stockholm Pilot has decided not to include the execution of local models as part of the Stockholm SMS functionality instead of local model integration the focus is to provide an easy and user friendly way for Stockholm end users to export 2D and 3D model data to the SMS system, for advanced visualisation.

Scenario evaluation and visualizations for urban planning: Two Stockholm emission scenarios have been elaborated for the year of 2030, with one scenario describing the emissions resulting in Stockholm after the completion of a new transit road and another scenario as a reference case. The results show the expected importance of climate change, changes in emissions in Europe and locally in Stockholm. The results were presented at the International Congress On Modelling And Simulation (MODSIM 2011) in Perth, Australia.

The SUDPLAN tool has been presented for two external end users who have environmental responsibility for the planned road transit solution. The two environmental experts have committed to participate in pilot validation.

In summary, the air quality downscaling work has generated substantial results that are already useful for the long term plan "Stockholm Vision 2030". More substantial progress in the visualisation will take place during the first half of 2012.

2. Air quality activities during 2011

The Stockholm pilot will demonstrate the SUDPLAN Scenario Management System (SMS) and its Common Services (CS) capability of air quality downscaling and climate scenario projections. SULVF representing the end users of the Stockholm Pilot applicaton, provides emission input and monitoring data for model evaluation. Generated local model results should be possible to be visualized in a 3D visualisation component that is part of the SMS.

Stockholm pilot activities have been defined in Section 2.6 of the D5.1.2 Pilot Definition Plan V2 for Stockholm. The activities have been categorized under three main areas, reflecting the overall role of the Stockholm pilot (Long term planning, Air Quality). The following tables 1a-c summarize Section 2.6 in the D5.1.2 document, commenting on activities performed during 2010 and 2011.

Table 1a Area 2.6.1 Using Common Services (see D5.1.2 document).

activity	***title***	***scheduled***	***status***
2.6.1.1	Presenting climate scenario information on the European scale.	M12	*Completed V2.*
2.6.1.2a	Intense rainfall downscaling: Just demonstrating that this is possible, SULVF will hand over results to external stakeholder (Stockholm Vatten).	M24	*Not focus for WP5, but is currently tested in WP6 and WP7. WP5 await V3 for demonstrating this SUDPLAN functionality.*
2.6.1.2b	Storm water generator: Just demonstrating that this is possible, SULVF will hand over results to external stakeholder (Stockholm Vatten).	M24	*Not yet implemented.* *WP5 await V3 for demonstrating this SUDPLAN functionality.*
2.6.1.3a	Air quality: urban downscaling for historical periods and validation of the model.	M12	*Completed V2.*
2.6.1.3b	Air quality: urban downscaling for various climate scenarios and with future emission scenarios.	M30	*Completed V2, results presented at MODSIM 2011, 12-16 December, Perth. Australia.*

Table 1b Area 2.6.2 Use of local models (see D5.1.2 document)

activity	***title***	***scheduled***	***status***
2.6.2.1	Design of advanced visualisations including 3D city map.	M12	*The design of 3D, and also 2D, visualisation completed V2 together with DFKI. A 3D map for the whole city has been delivered.*
2.6.2.2	High resolution grid model simulation.	M24	*Test output generated by local 3D grid model during V2.*
2.6.2.3	Street canyon model simulations.	M24	*Test area output generated during V1.*

Table 1c Area 2.6.3 Scenario evaluation and visualizations for urban planning (see D5.1.2 document).

activity	***title***	***scheduled***	***status***
2.6.3.1	Creation of different urban	M24	*Two scenarios for transit road in*

	planning scenarios.		*2030 completed V2.*
2.6.3.2	Grid model simulations of urban planning scenarios.	M24	*Completed V2, results presented at MODSIM 2011, 12-16 December, Perth, Australia.*

The work performed according to the status in the table above is described here in the following subsections. The corresponding work has been performed by the following persons:

Partner	**Person**	**Role**
SULVF	Christer Johansson	end user representative, expert on local data
	Boel Lövenheim	Stockholm emission scenarios, 3D buildings and topographic data
	Lars Törnquist	Local model database handling
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/mock-ups
Apertum	Lars Örtegren	expert on model system integration, user interface, visualization, linking SMS to CS and local model applications
	Per Ivarsson	expert on model system integration, user interface, emission databases

As a consequence of the ATR1 recommendation to involve external end users, SULVF has organized a workshop (August 26, 2011) together with two potential end users of SUDPLAN results. The two experts were presented the type of output that SUDPLAN will produce and they were asked to follow our development and participate in product validation to get the necessary external feedback. The ***two external end users as part of the WP5 team, with special focus on product validation issues,*** are:

- Mrs Marie Westin, Swedish Transport Administration and responsible for environmental aspects of the “Förbifart Stockholm” (Stockholm Transit) project.
- Mrs Marianne Klint, consultant of the WSP Sweden company, responsible for the Environmental Impact Assessment of “Förbifart Stockholm”.

They have been invited and agreed to participate in the LimeSurvey (web-based questionnaire) validation V2 of the WP5 pilot.

The following activity descriptions contain screenshots of the Graphical User Interface of the Scenario Management System that is the core result of WP3 work. The SMS can be directly used to display Common Service results that are the core result of WP4 work.

2.1. Activity 2.6.1.1 Presenting climate scenario information on the European scale

The SMS can be used to display climate scenario data (temperature and precipitation) as well as air quality projections (NO2, O3, SO2 and PM10) on the Pan-European scale (PE visualisation). Fig. 1 shows the SMS user interface for PE visualisation, which consists of a map window and a Capability window in the top right where PE services are displayed. Here some simple coastline and country border WMS maps are used as underlay. The climate and air quality results are structured under climate scenario names (here ECHAM5 and HADLEY, both based on A1B scenario but using RCP4.5 emissions for air quality simulations). The variables can be easily drawn into the map so that all 10-year averaged results can be visualised by sliding the time bar. The figure shows 10-years averages of particles, here centered at 1990.

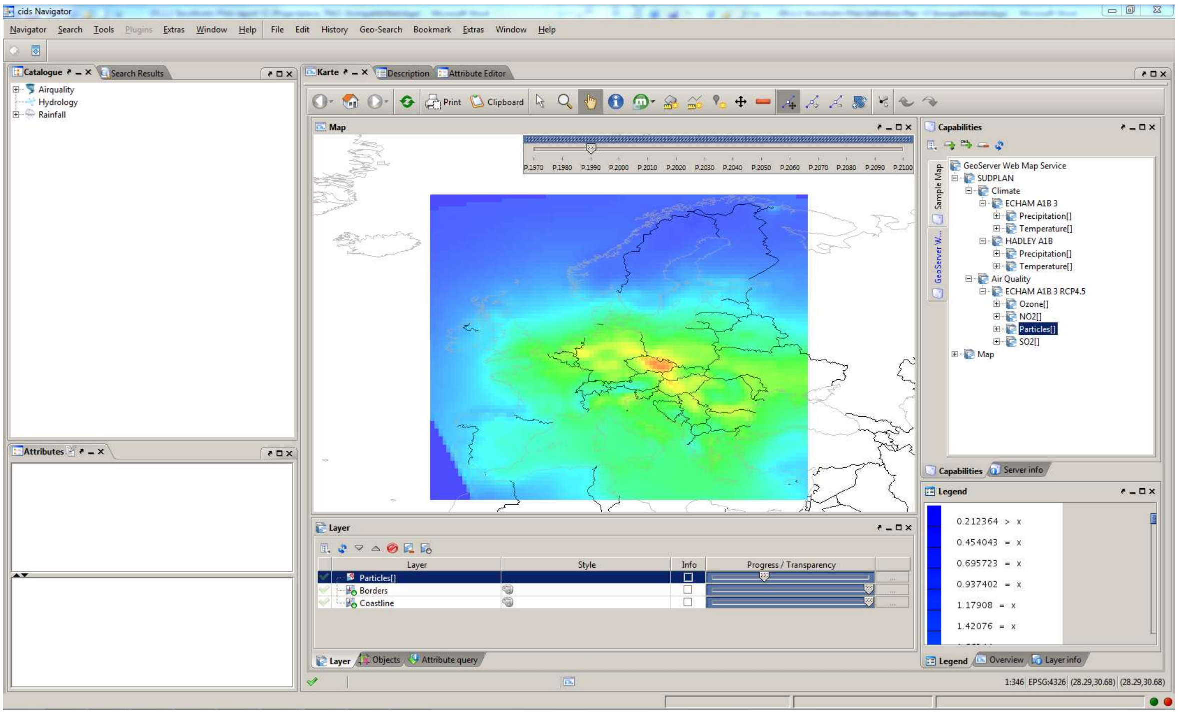


Fig. 1 The user interface of the SMS, visualising Pan-European climate and air quality variables.

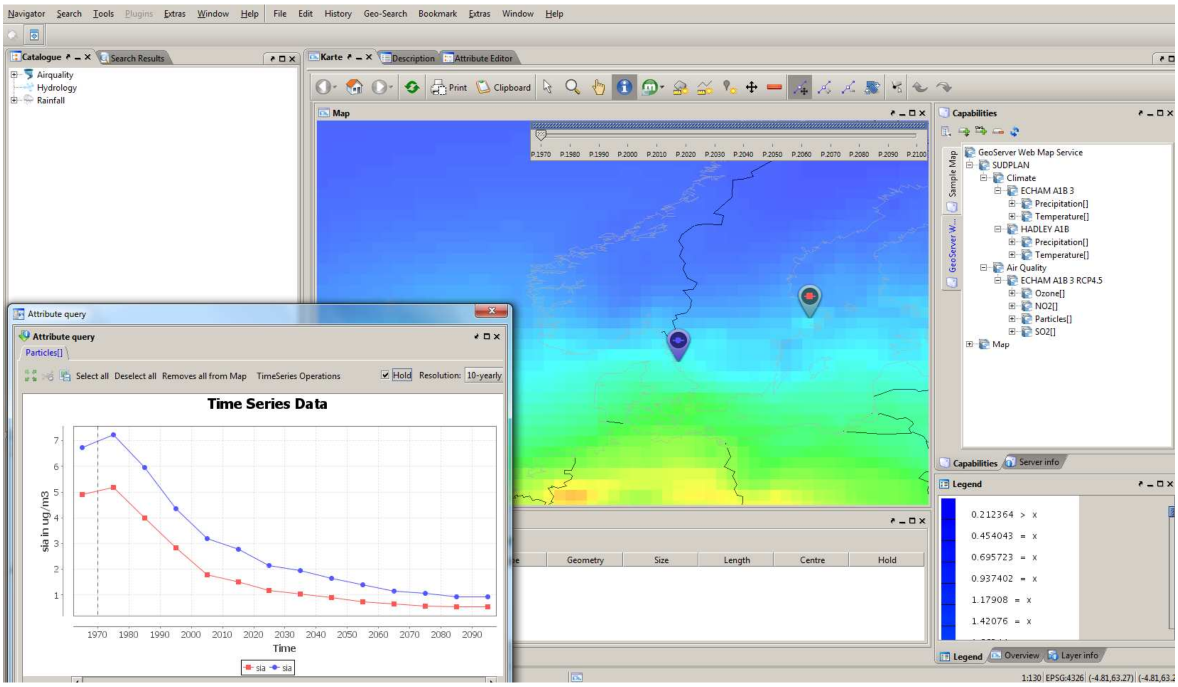


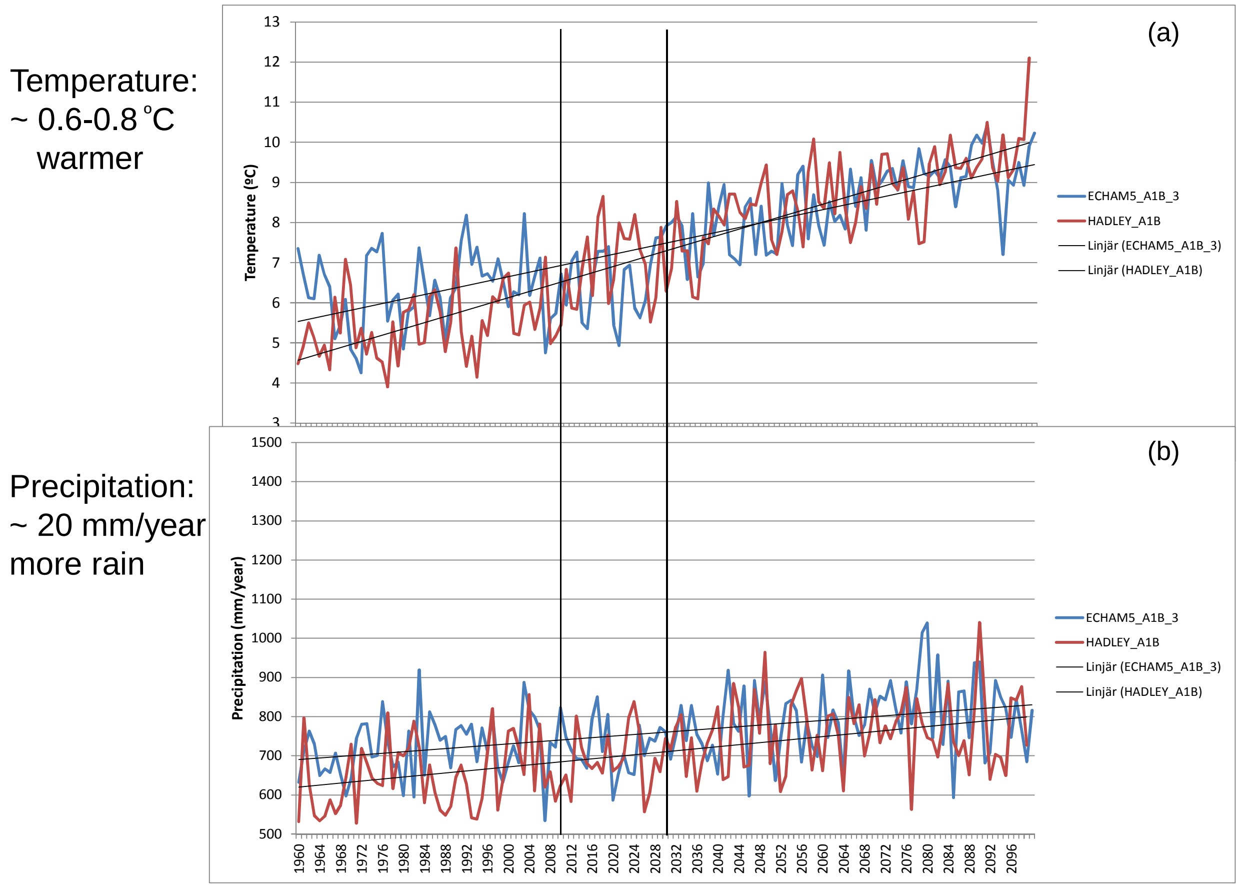
Fig. 2 Time series evolution of future PM concentrations in the two major Swedish cities.

It is also possible to visualize time series from selected locations within the map. Fig. 2 shows the expected evolution of particles – here represented by secondary inorganic aerosols (SIA) – in Stockholm (red line) and Gothenburg (blue).

The climate scenarios of Common Services have revealed the following information, of large use for projections of future air quality in Stockholm (Fig. 3). These figures are based on extraction of the Pan-European climate and air quality scenarios and show the expected evolution of temperature and precipitation as well as concentrations of ground-level ozone, nitrogen dioxide (NO_2) and secondary inorganic aerosols (SIA) between the years 1960-2100. The variation between 2010 and 2030 is analysed in more detail. According the calculations for Stockholm, the temperature is expected to increase by 0.6-0.8 ^{o}C between 2010-2030 while the corresponding value for the precipitation is 20 mm year^{-1}. If it was only climate that would change, this will likely imply an increase of concentrations of air pollutants, but since the effect of decreasing emissions are larger than the climate effect, the concentrations will also decrease; 2 µg m^{-3} for ground-level ozone, 0.5-1 µg m^{-3} for NO_2 and 0.6-0.8 µg m^{-3} for SIA.

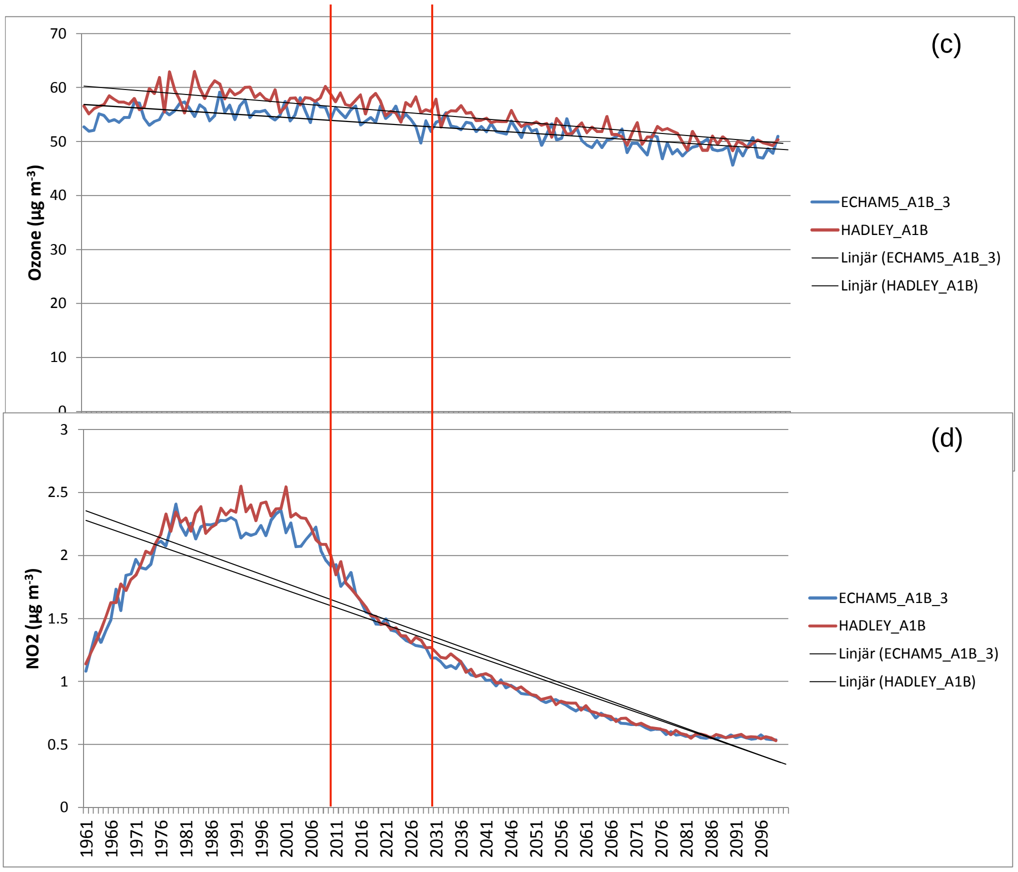
However, there are some uncertainties in the calculations. By presenting multiple results where different climate scenarios have been used, it is possible to get a quantitative estimate on how the future long range transport concentrations can vary. As can be seen from Fig. 3 the trends in simulations using either ECHAM5 or HADLEY GSMs are rather consistent, even if some differences in absolute levels - e.g. in ozone – can be observed. SUDPLAN will further make more climate scenarios available, as there are more uncertainties than just the GSM behind (the climate change effect) and the changes in European emissions. Another source of uncertainty is the formulation of the concentrations on the lateral boundaries, i.e. the hemispheric concentrations outside the European domain. For the two scenarios shown here, they have been kept the same for all the years (corresponding to the boundary concentrations in approximately year 2000). Studies have shown that a future increase of the boundary concentrations is expected (Langner et al., 2012). The magnitude of such an effect is discussed in sections here below

(Section 2.5) and will be further investigated in SUDPLAN WP5. It should also be clarified that SIA is only a part of the PM10 concentrations. There are some compounds and sources, contributing to the PM10 concentrations, that are excluded in the calculations, for example primary emission, sea salt, dust and secondary organic aerosols (SOA, biogenic and anthropogenic). The relative decrease in PM10 will therefore likely not be as large as SIA. This will also be addressed during the last year of the SUDPLAN project.



Ozone:
~ 2 µgm^{-3}
lower
concentration

NO2:
~ 0.5-1 µgm^{-3}
lower
concentration



SIA:
~ 0.6-0.8 µgm^{-3}
lower
concentration

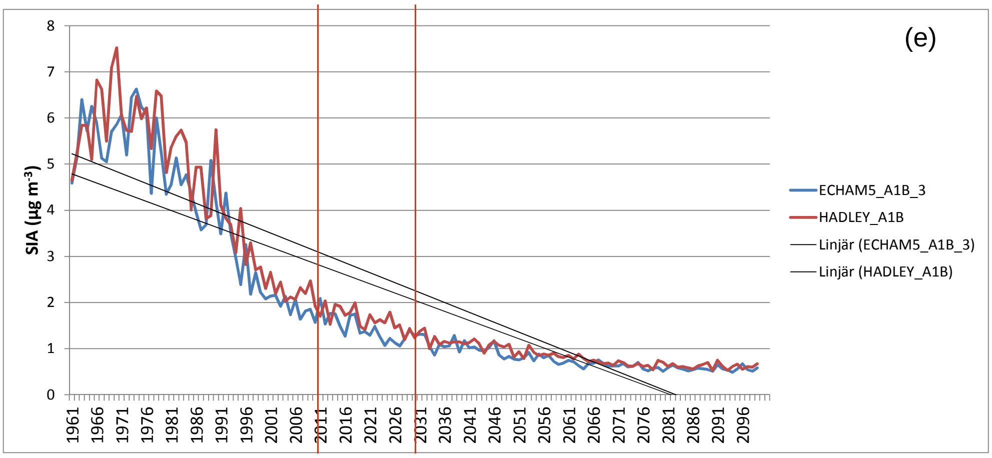


Fig. 3 Extractions from Pan-European climate and air quality scenarios. The figures show future projections for (a) temperature, (b) precipitation, (c) ozone, (d) NO2 and (e) SIA.

2.2. Activity 2.6.1.2a Rainfall downscaling

This service functionality is available for two types of uploaded input data, either high temporal resolution precipitation data or IDF curves/tables from the specific region. Since rainfall services are focus for both WP6 (Wuppertal pilot) and WP7 (Linz pilot), we will await their results before presenting this CS functionality to potential Stockholm end users. Thus, the functionality will be demonstrated in V3.

2.3. Activity 2.6.1.2b Storm water generator

This will give gridded precipitation distributions for a shorter period. The service is not implemented in V2, but will be demonstrated in V3.

2.4. Activity 2.6.1.3a Urban air quality downscaling for a historical periods and validation of the model

This activity has been solved through experimentation performed using the web-based Air Quality Management System Airviro, which is owned by the partners Apertum and SMHI. Airviro is used as a part of the productive system of the City of Stockholm so WP5 users are familiar with the software.

The year 2010 was selected for validation purposes. The simulations were based on emission factors from ARTEMIS (André et al., 2008) and covered a 102x102 km^2 area with a resolution of 2x2 km^2. The meteorological forcing was taken from the HIRLAM weather forecast model and the boundary conditions were prescribed on a monthly basis so that seasonal changes were taken into account. The results are presented together as annual averages for four variables, together with monitored data as well as simulations using climate scenario forcing instead of "true" data (Fig. 4).

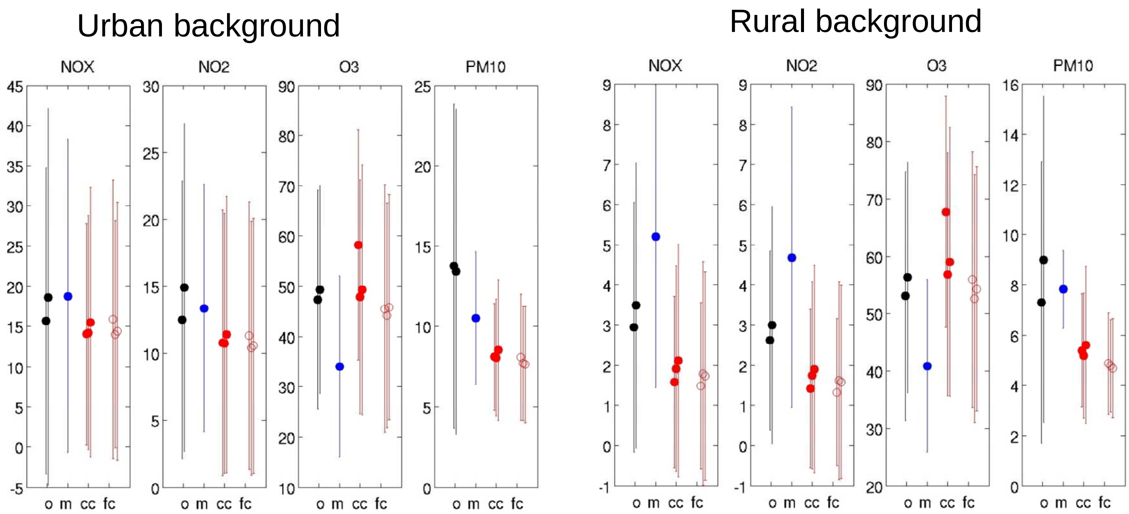


Fig. 4 Comparison of annual average concentrations (bars indication max/min) for 2010 from measurements (black circles), MATCH model for 2010 using HIRLAM and EMEP emissions (blue circles), MATCH model using ECHAM5 climate model for 2010 (filled red circles) and for 2030 (empty red circles). Urban background refers to Torkel Knutson station in central Stockholm (roof level) and the rural station to Norra Malma outside Stockholm.

The comparison partly shows good agreement, but is not completely satisfactory. The downscaling describes well NOx/NO2 levels in the urban background, both using historical "true" meteorology for 2010 as well as the climate scenarios representation of 2010. Clearly the model works well here and this can also be seen in the time series comparison below (Fig. 5). In the rural background the differences are not so large in absolute numbers (note another scale on the y-axis), however, it is difficult to explain why the simulated values based on true 2010 data differ so much from those based on climate scenario forcing (Fig. 4). This should be better understood.

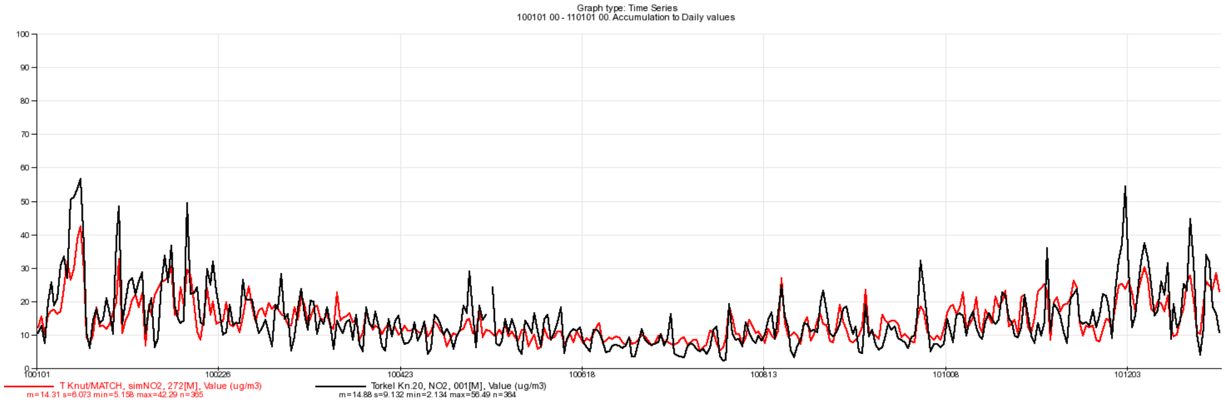


Fig. 5 Comparison of daily NO2 levels at urban background station Torkel Knutson for 2010. Model simulated data in red and measurements in black.

For ozone there is a strange difference between the "true" 2010 data simulations and the climate scenarios, actually the latter are much closer to the measured levels. There are reasons to study other differences (e.g. emissions, boundary conditions) between the simulations with "true" 2010 meteorology and those with climate scenario forcing. As will be shown in Section 2.5 the downscaling based on climate scenarios compares well to measured ozone levels, which justify the conclusions made in that section.

For PM10 the results are promising, in light of the fact that we do not have all long range components included in the incoming air. Presently these are based on secondary inorganic aerosols (SIA) only, excluding organic compounds, primary PM and sea salt. Future work will incorporate these components, so that levels come closer to those observed. We can also see that local PM10 emissions seem to not be fully described (and we know that they do not have the seasonal behaviour as seen in measurements). Still the conclusions from the Section 2.10 below (assessment of two future emission scenarios for Stockholm), based on simulated trends in PM10 between 2010 and 2030, can be justified.

2.5. Activity 2.6.1.3b Urban air quality downscaling for climate scenarios

In this activity downscaling simulations have been made with the objective to show how changes in air pollution in the long range transported incoming air will affect local air pollution in Stockholm. For that purpose we have simulated three years 2009-2011 as representing present conditions and then three future years 2029-2031. The reason to use three years is to illustrate some of the year-to-year variability in air pollution concentrations.

There are three basic factors that affect the incoming air concentrations. One is due to climate change, where higher temperatures and changes in precipitation will have effects on pollutant concentrations. Especially ozone is expected to increase if temperature rises. Fig. 6 shows that for northern Europe this is not the case, rather the true climate effect (keeping boundary conditions and European emissions fixed at year 2000 level, as exemplified by the Hadley and ECHAM5 results in the top of Fig. 6, shows the ozone levels to be constant over time. For southern Europe the corresponding results indicate a certain increase in ozone levels (not shown).

Fig. 6 shows also the corresponding evolution of future ozone levels when European emissions reductions are taken into account (a significant decrease, bottom line in the figure) and also when the ozone levels at the boundaries are increasing with 0.2 ppb/year (counteract the decrease so that ozone will be constant over time). We have thus demonstrated that levels of ozone in the incoming air to Stockholm will not increase due to climate change, but rather be determined by either emission reductions in Europe (ozone decrease) or increasing ozone levels on the hemispheric scale (ozone increase). The latter two effects are of the same magnitude and may balance each other.

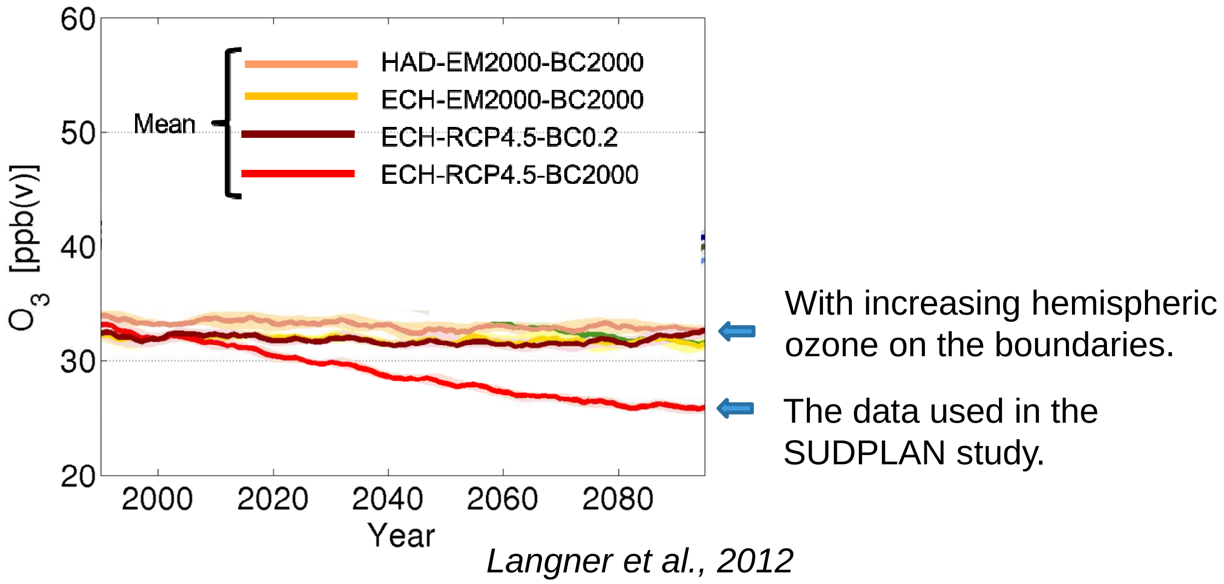


Fig. 6 European scale simulations showing annual average ozone concentrations spatially averaged north of 50 ºN (representing northern Europe), using HADLEY A1B climate and fixed emissions as well as hemispheric boundary conditions (orange) and correspondning simulation with ECHAM5 A1B_3 (yellow). Then only for ECHAM5 A1B_3 adding time varying emissions (red) and finally also time varying boundary condtions (a yearly increase of 0.2 ppb).

The downscaling experimentation over Stockholm, as discussed in this section, has been performed with two climate scenarios, both using the expected emission reductions in Europe but with fixed (but seasonally varying) concentrations on the European boundaries and with fixed emissions inside the downscaled domain.

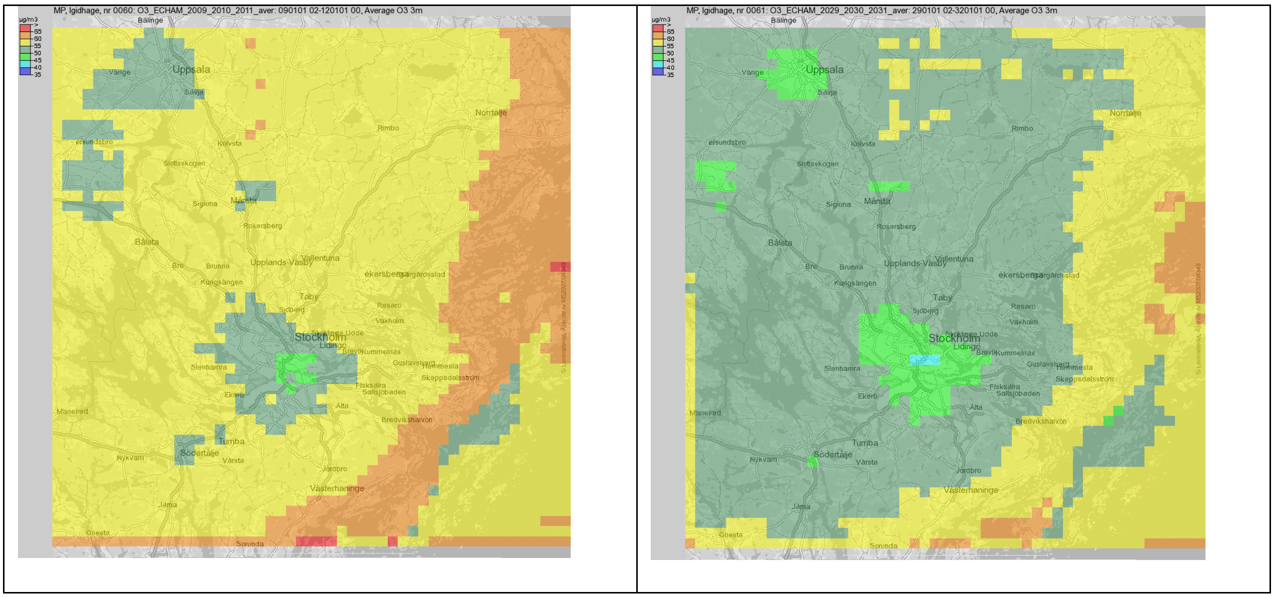


Fig. 7 Average levels of urban background ozone concentrations: Year 2009-2011 (left) and year 2029-2031 (right) with ECHAM5 A1B climate scenario and RCP4.5 time varying emissions, assuming Stockholm emissions are kept constant at 2010 year level.

For ozone the highest values are found in the periphery of the city, especially over the Baltic Sea to the east (Figure 7). Central urban ozone levels are lower since locally emitted NO will consume ozone while oxidized to NO_2. As the same emission inventory of 2010 is used both for the 2009-2011 and the 2029-2031 downscaling, total ozone will respond to changes in incoming long range transported air and the reduction is similar over the Stockholm area. The average ozone reduction is minor, about 5 µg m^{-3} (~10%) from year ~2010 to year ~2030.

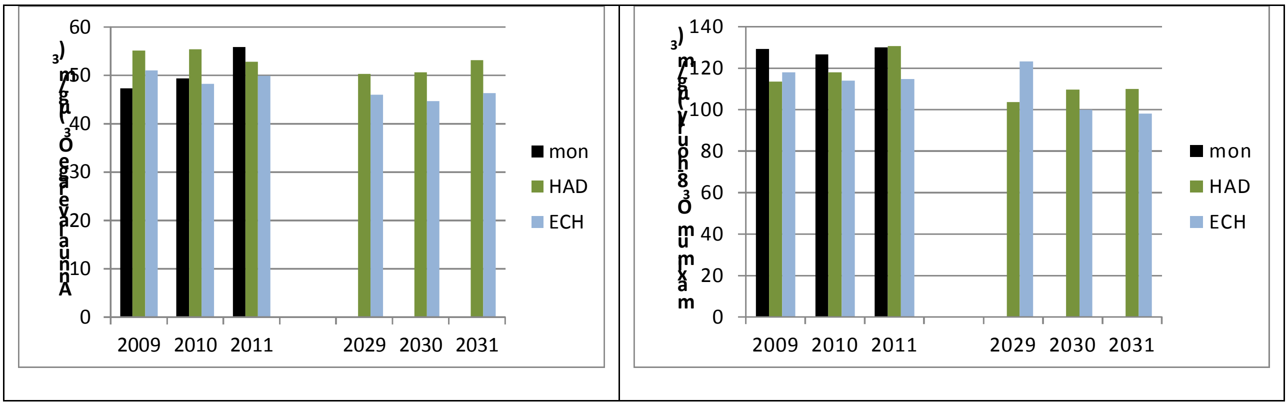


Fig. 8 Urban background concentrations of ozone in the centre of Stockholm (monitor stations "Torkel Knutsson", located at roof level): Annual averages (left) and maximum 8-hour running mean values (right, with 2011 measured value based on summer period only).

In Fig. 8 the modelled annual average and maximum 8-hour running mean values, are evaluated in the city centre, at the monitoring station "Torkel Knutsson". Measured values compare reasonably well to simulated levels, however, a year-to-year similarity cannot be expected as the climate scenario meteorology does not reflect actual meteorological conditions for those three particular years. Although three-year averaged ozone levels show a smaller decreasing tendency, there is an important year-to-year variability. This is even most striking for extreme values, as the maximum 8-hour mean value labelled "2029" is higher than for any other year (HADCM3 based downscaling Fig. 8, right diagram).

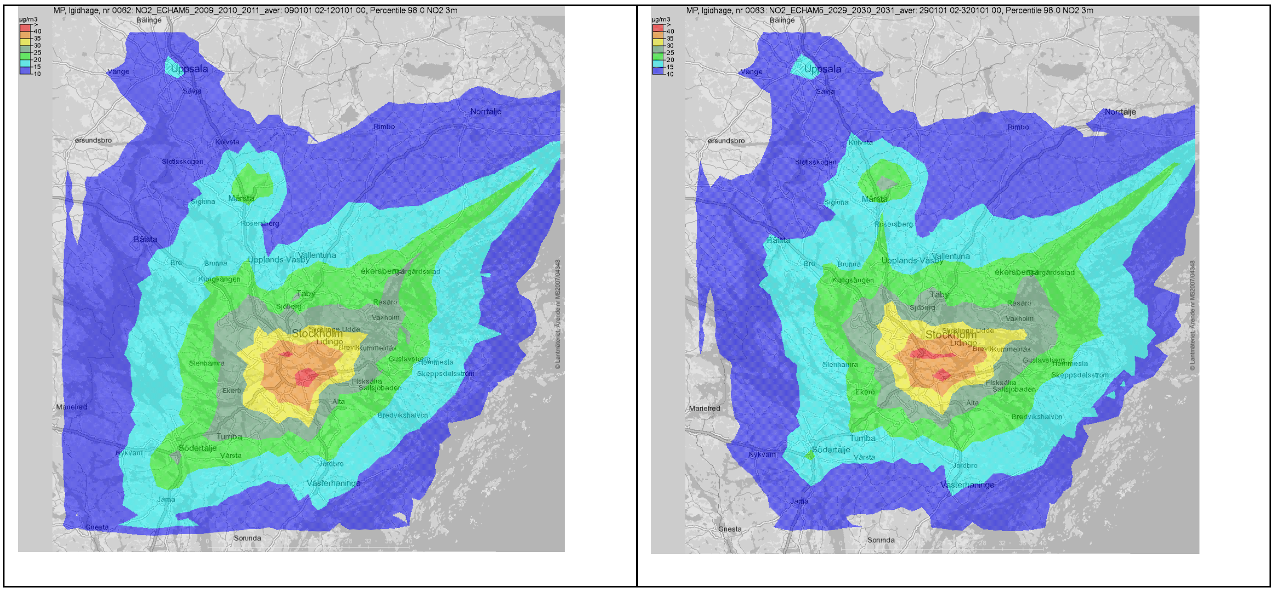


Fig. 9 Extreme levels – 98-percentiles of hourly values - for urban background concentrations of nitrogen dioxide: Year 2009-2011 (left) and year 2029-2031 (right) with ECHAM5 A1B climate scenario and RCP4.5 time varying emissions. Local emissions within the downscaling domain kept constant at year 2010 level.

The corresponding comparisons for nitrogen dioxide are shown in Fig. 9 and 10. The expected reduction of NO_2 in future long range transport is not sufficient to reduce city centre concentrations. Variations from year to year seem larger than long term differences between 2009-2011 and 2029-2031. Measured concentrations from 2009 and 2010 indicate a large inter-annual variability compared to the differences in calculated NO_2 concentrations.

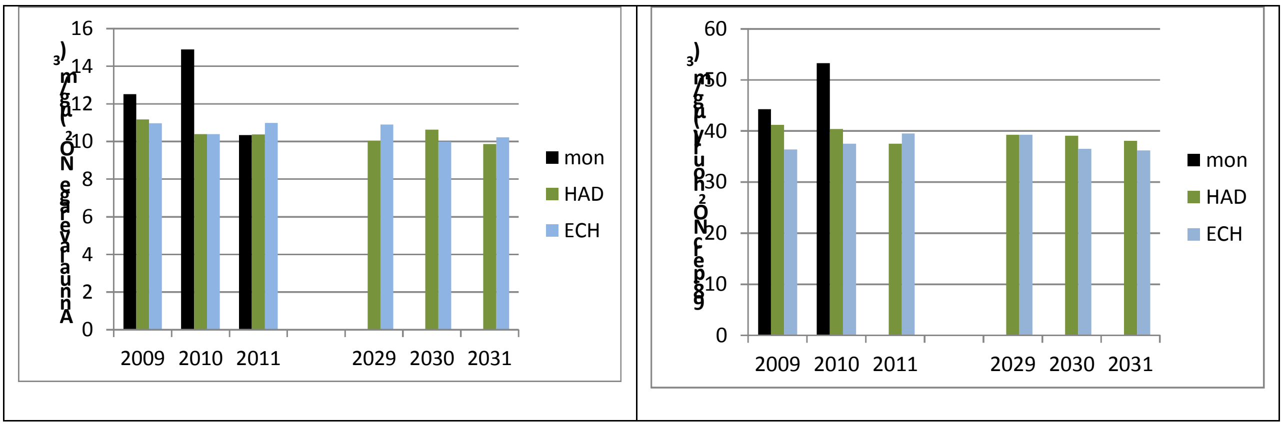


Fig. 10 Urban background concentrations of nitrogen dioxide in the center of Stockholm (monitor stations “Torkel Knutsson”, located at roof level): Annual averages (left) and 98-percentiles of hourly values (right).

Results of downscaling experiments where also Stockholm emissions are changing are discussed in Section 2.9 and 2.10.

2.6. Activity 2.6.2.1 Design of advanced visualisations including 3D city map

The presentation of air quality will use both 2D and 3D visualisation. The 2D and 3D designs are slightly different and thus outlined separately (texts taken from internal work documents elaborated between WP3-WP4).

2.6.1 2D visualisations

All 2D visualisations will use the coordinate system usually used by city end-users for planning purposes. Default for CS, until such map is identified, is the WGS84 projection and the same maps as used for the 3D visualisation. The local map will be delivered as a WMS or geo-referenced image and made available in the SMS. The CS models will automatically adjust to the coordinate systems of the map used while ordering the downscaling.

The CS air quality output is always time series of 2D grids representing concentrations of NOx, NO2, SO2, O3 and PM10 at ground level. CS produces hourly data, but delivers in parallel (depending on the simulation length) daily, monthly, yearly and 10-yearly average grids. Note that for yearly time resolution and higher, the time series of grids may be just one individual 2D grid.

General requirements:

The visualisation is expected as coloured grids above the map in grey tones. It should be easy to switch between different pollutants and step forward/backward in time. It should be possible to open various windows to compare the levels of different pollutants.

There will be two possible operations:

1. Simple mathematical operations on one or multiple result grids (e.g. difference between two yearly average grids), creating a new grid that can be stored in the repository.

2. Point in result grid yielding a time series from that location (same functionality as in PE), with possibility to export out of SMS.

This visualisation deals with standard CS AQ downscaled grid data, available directly in SMS through the OGC communication between SMS and CS.

The SMS will be able visualise coloured 2D grids over grey tone maps. The data sets from CS will have temporal resolution hourly, daily, monthly, annual and 10-years (the latter will be rare, since normal AQ downscaling runs are made for only one year).

The user will be able to go back and forth in time using a slider (as in PE). We expect individual colour scales for the five pollutants NOX, NO2, O3, SO2 and PM10, with possibility for the user to edit the default scales along personal preferences (Table 2).

Table 2 Default colour scales for visualisation of air quality result grids (10-year results should have the same colour scales as annual).

NO2 & NOx	annual	monthly	Daily	hourly
7	40	40	60	90

6	32	32	48	72
5	26	26	36	54
4	20	20	30	40
3	14	14	24	30
2	8	8	18	25
1	3	3	12	20

PM10	annual	monthly	Daily	hourly
7	40	40	50	100
6	32	32	40	80
5	24	24	30	60
4	16	16	20	40
3	8	8	15	20
2	4	4	10	10
1	2	2	5	5

SO2	annual	monthly	Daily	hourly
7	40	40	125	200
6	32	32	100	150
5	24	24	75	100
4	16	16	50	75
3	8	8	25	50
2	4	4	10	25
1	2	2	5	10

O3	annual	monthly	Daily	hourly
7	120	120	240	240
6	100	100	180	180
5	80	80	120	120
4	60	60	100	100
3	50	50	80	80
2	40	40	60	60
1	30	30	40	40

Fig. 11 gives an example of the expected presentation (similar to the visualisation on the European scale). The time series output from a given location will be possible to export out of SMS in CVS or other common format.

Metadata (text) belonging to a particular CS AQ downscaling result will be possible to show along with the graphical visualisation.

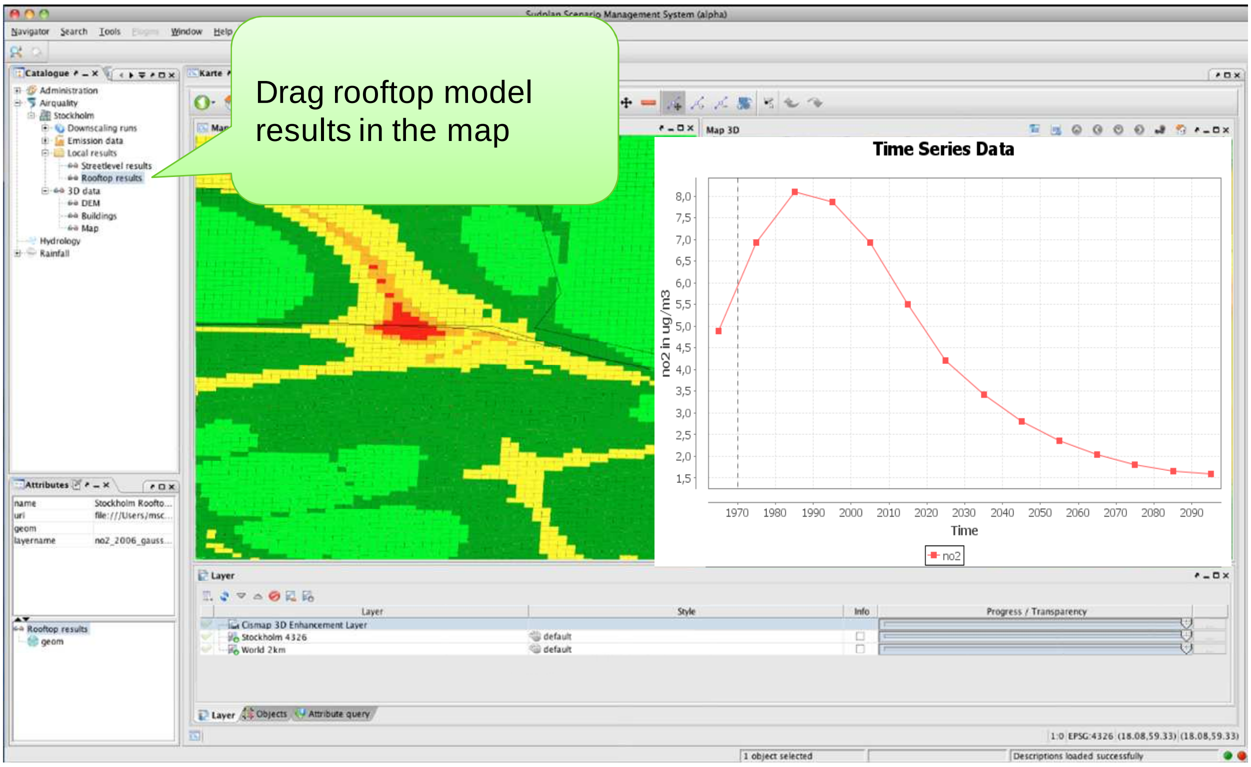


Fig. 11 Example of 2D grid visualisation (left) and time series output after pointing at a specific location and asking for time series output (hourly, daily, monthly or yearly).

2.6.2 3D visualisations

All 3D visualisations use a 3D building map as a base. The building map should be delivered as a 2D shape file with house heights as attribute (2.5 D).

The following air quality results can be combined with the 3D building map:

- Road link data from SIMAIR results
- 2D gridded concentrations fields
- 3D gridded concentrations fields

The data can be displayed individually or in combination. The user is able to select/deselect different data “layers” interactively, e.g a combination of road link data and 2D (or 3D) grids (**Fig. 12** Combination of building model, road link data and 2D air quality results (Södermalm/Stockholm).

2).

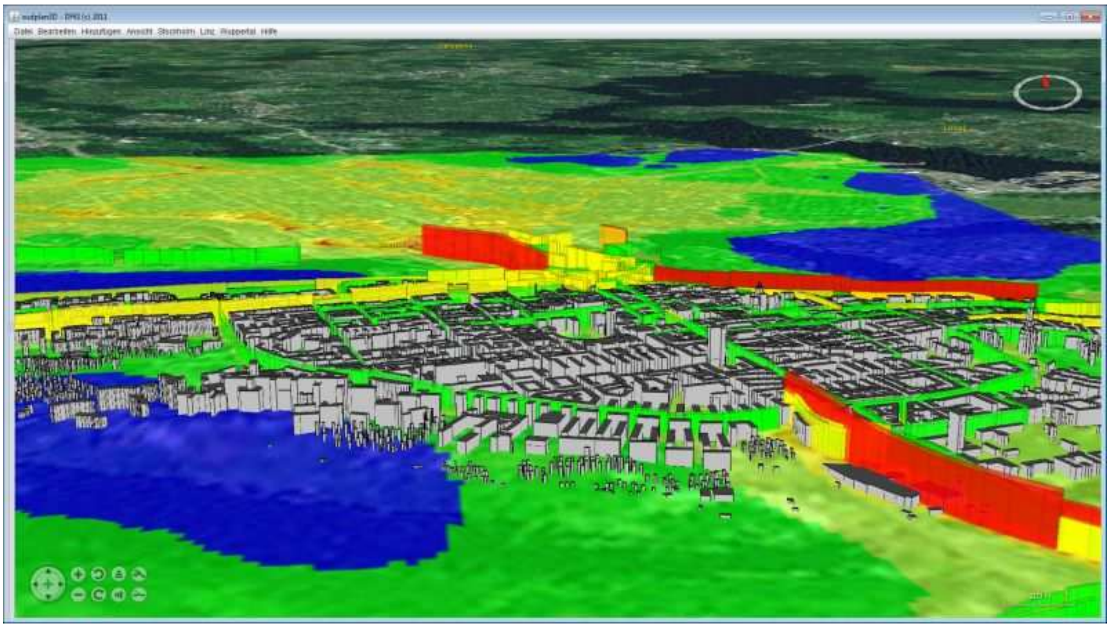


Fig. 12 Combination of building model, road link data and 2D air quality results (Södermalm/Stockholm).

General requirements:

The data should be accompanied by additional information and uploaded to the SMS. The coordinate system in which the data is stored should be WGS84. (This should be easy to change to before exporting the data from the used GIS system).

3D buildings should be represented as 2D floor plans with (at least) an accompanying height attribute.

The SMS will read shape files with 2D buildings where building height is given as an attribute. The building foot prints should be given as ShapeType:POLYGON in WGS84 coordinates.

Remarks: At least the building height should be given as an attribute. This attribute needs to be named "Height" and it should give the real height of the building from ground level. NOT above sea level! If the building height is calculated each time based on the underlying DEM (there could be multiple DEMs with different accuracy/resolution) the building heights will be wrong because of possible DEM differences.

Additional attributes like usage/house type are welcome but should be described in the additional document. There should be AT LEAST a translation of the attribute names and the possible values (e.g. house types) in the document!

In addition to provide the 3D buildings as (shape-) files the data can be retrieved from a web service (e.g. WFS with building foot prints as features and height as one of the attributes). This will be defined at a later stage by WP3 partners.

The SMS will read shape files representing ***road link data from the SIMAIR model system***. The geometry (lines) should be given as ShapeType:Polyline in WGS84 coordinates with air quality values as attributes. Road link data should be represented as line elements with air quality values as attributes.

There will also be a text file providing metadata to the user, e.g. with information on model domain, map, emission database, description given by user while executing the model run etc. The results are statistical output (averages, percentiles etc) from annual simulations, i.e. no time series. The attributes of each road link is given below:

FID	Shape	Name	Info	ADT	RecDist	Model	NrVehTot	NrVehLDV	NrVehHDV	EmisTot	EmisLDV	EmisHDV	Local	Total	Perc98h	Perc98d	RBu	RBs	UB	RoadLen	RoadDir	Pos	CalcDate
0	Polyline	72741 73061	72741 73061	1738	0	OSPM	1723	1706	17	16	14	2	4	19	53	38	1	1	12	154	113	NO	2010-09-17 11:43
1	Polyline	72741 73061	72741 73061	1738	0	OSPM	1723	1706	17	16	14	2	5	20	53	38	1	1	12	154	113	SV	2010-09-17 11:43
2	Polyline	73311 72768	73311 72768	1044	0	OSPM	10354	9901	452	135	83	51	20	35	78	66	1	1	12	474	211	SO	2010-09-17 11:43
3	Polyline	73311 72768	73311 72768	1044	0	OSPM	10354	9901	452	135	83	51	21	36	79	61	1	1	12	474	211	NV	2010-09-17 11:43
4	Polyline	73863 72906	73863 72906	1820	0	OSPM	18046	17849	197	161	138	23	23	38	77	63	1	1	12	892	331	SV	2010-09-17 11:43
5	Polyline	73863 72906	73863 72906	1820	0	OSPM	18046	17849	197	161	138	23	19	34	78	68	1	1	12	892	331	NO	2010-09-17 11:43

The visualisation can either be just one result (e.g. “Total” concentration) or two (as in the **Fig. 13** Visualisation of road link data. Colour: air quality, height: number of vehicles/day.

13, where colour is “Total” and height is “NrVehTot”).

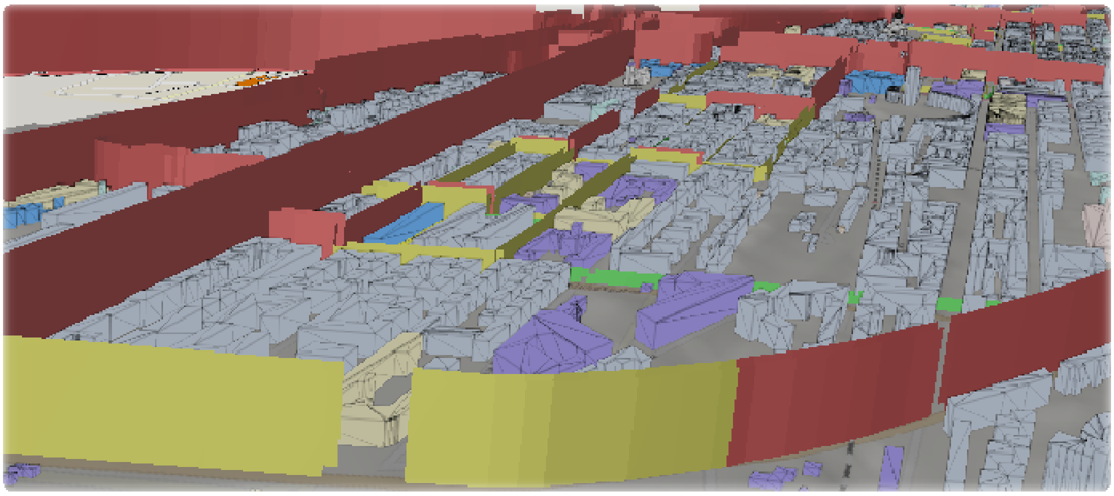


Fig. 13 Visualisation of road link data. Colour: air quality, height: number of vehicles/day.

The default colour scale for each pollutant (e.g. “PM10”) and type of value (“e.g. max daily average”, in SIMAIR “Perc90d”) will be as suggested in the Table 3 below. If the user wants only to present one result, he should be able to specify a homogeneous height of the visualised segments, e.g. 20 m.

The available road link data from Södermalm can be used as test data set.

For the 3rd version of the software it may be possible to provide road link data as (shape-) files the data can be retrieved from a web service (e.g. WFS with road links as features and values as attributes). This will be defined in a later stage with the help of WP3 partners (cismet, DFKI).

The visualisation of ***gridded 2D and 3D model results***, generated either as standard CS AQ downscaling results that are available directly in the SMS or as locally produced 2D or 3D model results produced outside SUDPLAN and subsequently imported to SMS. The SMS should be able to visualise 2D and 3D gridded data above 3D building maps.

2D: The user will be able to define the height for the visualisation (even if the height is given by the model, there may be "visualisation" reasons to put them on another height, e.g. depending on the typical height of the building).

3D: The height of the different layers will be given implicitly (e.g. filename, metadata). If single layers of the data are used for visualisation the user should be able to manipulate the height (as in the 2D case)

The 2D/3D gridded data may consist of averages, percentiles or time series (hourly values).

Results generated outside SUDPLAN should come as three types of files:

- A text file containing the meta data of interest for the user (one meta data file for each set of data, i.e. one pollutant for several levels and time stamps).
- A "prj-file" with projection information given together with shp, shx and dbf files. The data needs to be in the WGS84 coordinate system.
- A shape file for each pollutant and each level (in 3D). There are two types, statistical data and time series.
    - The statistical result files should have one attribute for each statistical measure, e.g. average, 98-perc daily and 98-perc hourly data.
    - The time series files should have one attribute for each time stamp. In Stockholm there will normally be hourly data. Shape files can only have 255 attributes, so this type of data files should be limited to one day (24 attributes) or one week (168 attributes). The use of 3D time series of grids is basically to allow animation, e.g. what happens during a day (we could also imagine monthly values to animate seasonal behaviour).

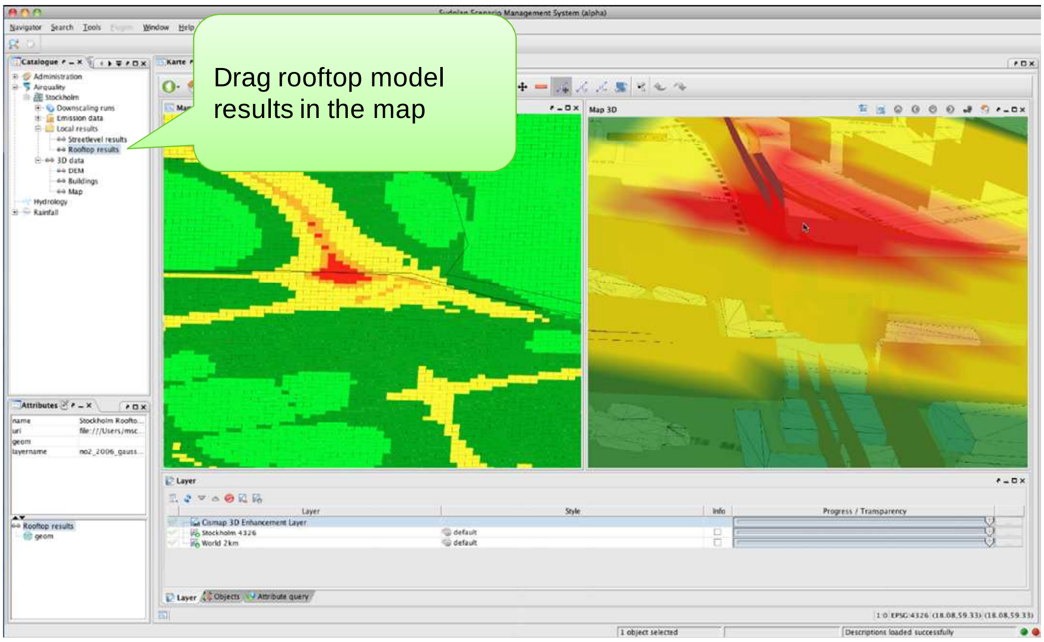


Fig. 14 Example visualisation for 2D gridded data (rooftop results) over the 3D city model.

Table 3 Recommended default colour scale for local model: SIMAIR line segment results.

NO2	annual	98-perc daily	98-perc hourly
7	40	60	90
6	32	48	72
5	26	36	54
4	20	30	40
3	14	24	30
2	8	18	25
1	3	12	20

PM10	annual	90-perc daily	98-perc daily
7	40	50	50
6	32	40	40
5	24	35	35
4	16	30	30
3	8	25	25
2	4	20	20
1	2	15	15

Table 4 Local model results of ozone (gridded 2D/3D data.

O3	Max 8h (daily)
7	240
6	180
5	120
4	100
3	80
2	60
1	40

2.7. Activity 2.6.2.2 High resolution grid model simulation

The example has been taken from the central part of Stockholm, using 2010 year emission database and the Airviro grid model (part of SULVF air quality management system). A week long simulation of NOx was made over a 7x7 km^2 area with 50x50 m^2 spatial resolution and with 13 layers in the vertical. In Fig. 15 it is possible to see the impact patterns of traffic sources (most pronounced at ground level) and point sources (appearing higher up, here at 200 m height).

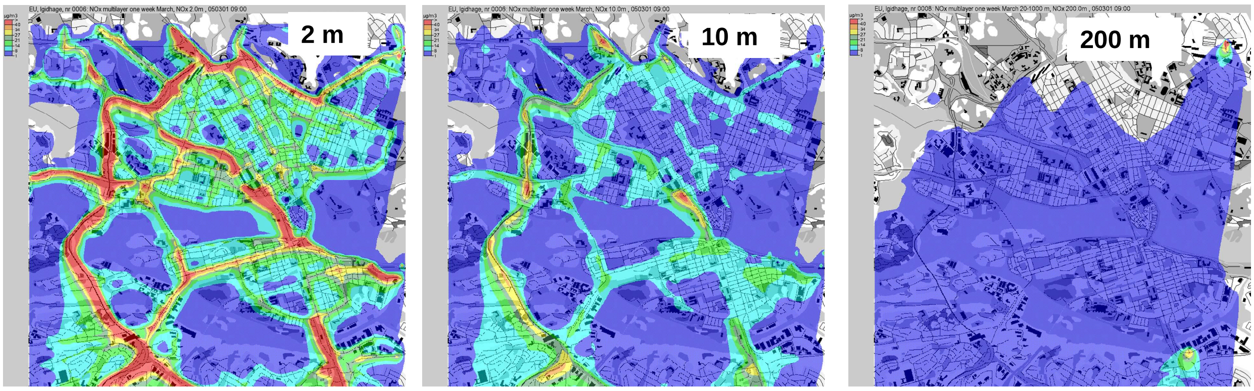


Fig. 15 NOx concentrations during a morning rush hour, at 2m height (left), 10m (center) and 200 m height (right).

This data set is used for testing the 3D visualisation according to Section 2.6.2.

2.8. Activity 2.6.2.3 Street canyon model simulations

The concentrations of NO2 in street canyons at Södermalm in central Stockholm, used in the 3D visualisation shown in Fig. 13, have been simulated with the air quality model system SIMAIR (Gidhagen et al., 2009). The model is a national web based air quality system that can be used by all Swedish municipalities to assess their air pollution levels and how they compare with the EU Air Quality Directive targets. SIMAIR is a coupled model system, i.e. databases and dispersion models on different spatial scales are used in order to calculate the total concentration. This also makes it possible to separate contributions from different scales. For calculations of local concentrations in street canyons, the OSPM model is used (Berkowicz, 2000), while the OpenRoad model is used for open streets with no surrounding buildings (Gidhagen et al., 2004).

In Fig. 16 annual mean concentrations of NO2 are shown for the street canyons and open roads at Södermalm in central Stockholm; the model domain for this dataset. The figure shows total concentrations, i.e. concentrations including background concentrations. However, the local contribution from the local road traffic is the only part that is included in the 3D visualisation in Fig. 13. The simulations have been made for emissions, meteorology and traffic information regarding year 2004. All in data (traffic amounts etc.) have not completely been quality checked. Thus, these calculations can be regarded as tentative and the main purpose of the dataset is to demonstrate the 2D and 3D visualisation in Section 2.6.

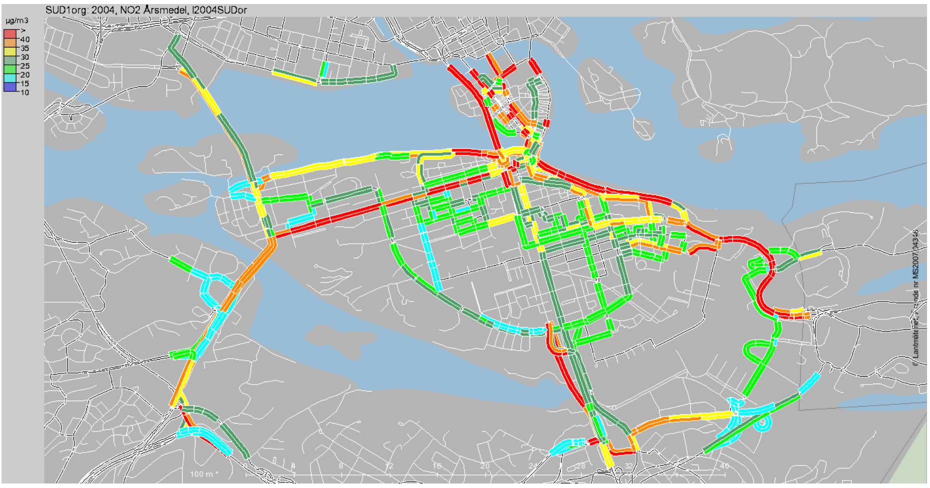


Fig. 16 Calculation of NO2 annual mean concentrations (total concentrations) for Södermalm in Stockholm. Streets with more traffic than 1000 vehicles/day are included. Simulations have been made with the SIMAIR model system, using the local dispersion model OSPM for street canyons and the OpenRoad model for open streets. Emissions, meteorology and traffic data are valid for year 2004.

2.9. Activity 2.6.3.1 Creation of different urban planning scenarios

The SULVF local model system (Airviro) has been used to create two traffic emission scenarios for the year 2030. The two scenarios describe the emissions in a situation with or without the bypass highway. In addition, a database with the current emissions (2010) is used for comparison.

Traffic prognoses are obtained from a national traffic prognosis model system called Sampers; a travel demand forecasting tool. It is mainly based on travel enquiries and describes the transports using cars, public transport, cycling and walking depending on the distances, destination, availability of different transportations etc. It also includes a model that considers peoples willingness to pay in order to account for taxes e g the congestion tax in central Stockholm.

The two scenarios with and without the transit road have the same land-use. With the transit road the existing congestion tax zone is extended and includes a tax on the highway-ring around the inner city. This additional tax extension is not included in the scenario without the transit road, the motivation being that there must be a way to bypass Stockholm without having to pay a tax. The number of vehicles on the main roads in the two scenarios is shown in Fig. 17.

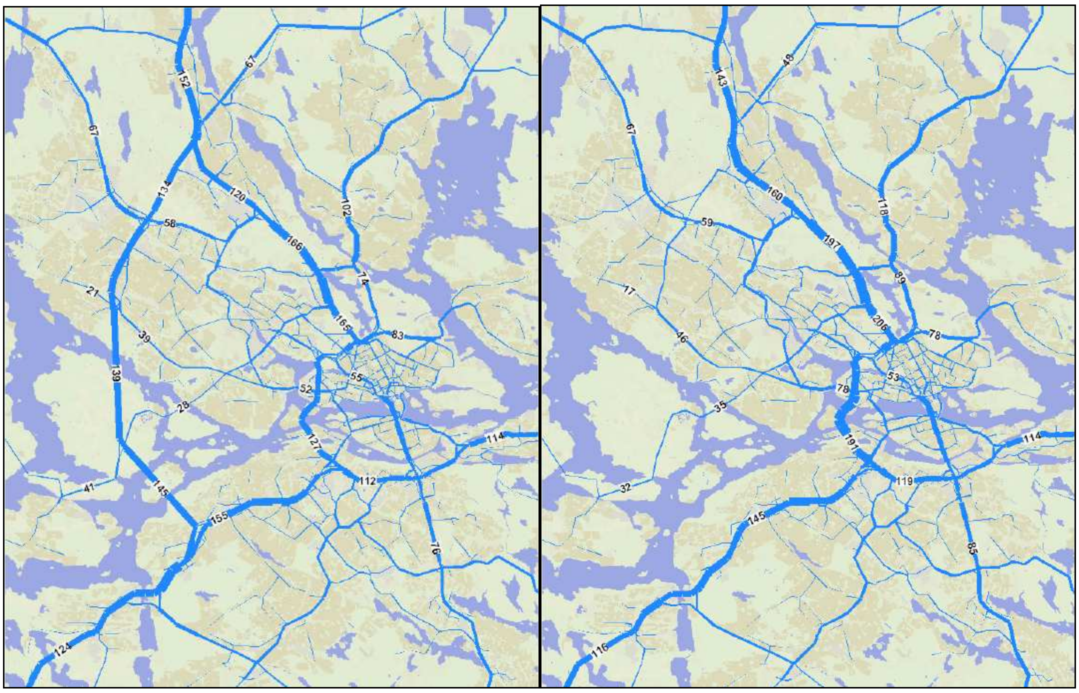
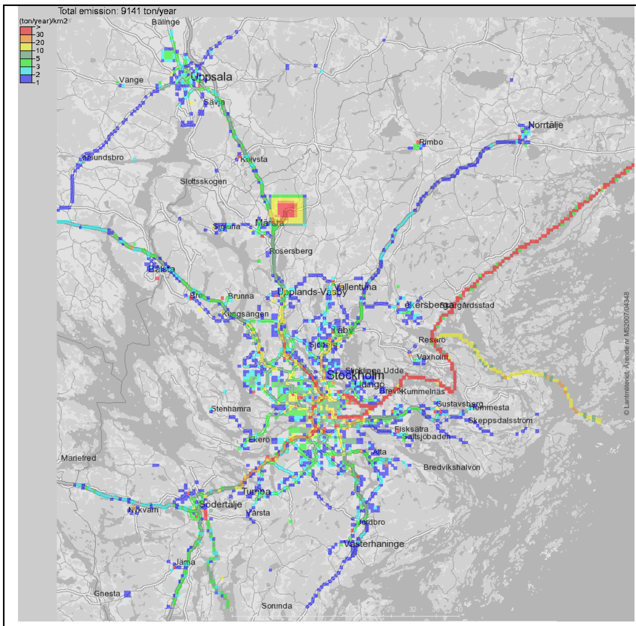


Fig. 17 Number of thousand vehicles per day on the main roads with (left) and without (right) the transit road for the year 2035.

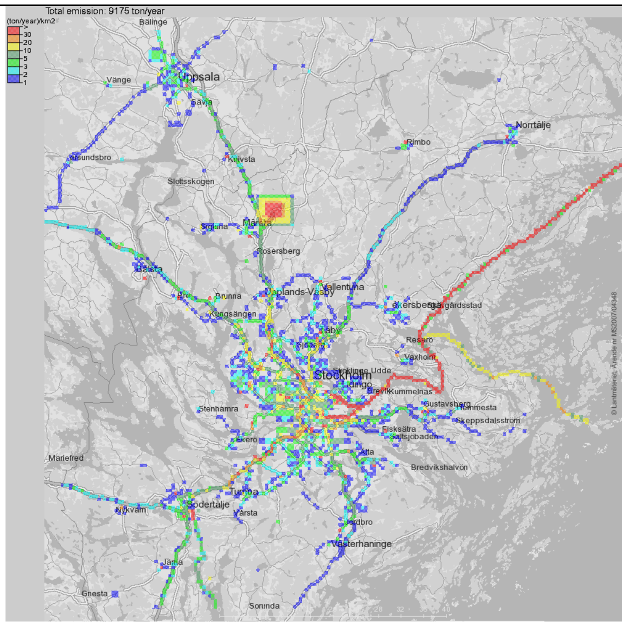
As shown in Fig. 18 the difference in total NOx and PM10 emissions over the area with and without the road transit in 2030 is quite small (<1 %). Since most of the transit road will be constructed as an underground highway road tunnel ca 10 km west of the city centre, the location of the emissions will be very different compared to a case with a highway on the ground. Most emissions from the tunnel will be ventilated in 10 to 20 meter high towers. Some emissions will occur at tunnel exits at ground surface level.

The largest difference between the two alternatives is that there will be much less traffic emissions close to the city centre with the transit road. The transit road tunnel is expected to reduce the exposure to traffic emission of a large fraction of the population. Another important point is that special actions are planned to keep the emissions of PM10 inside the tunnel as low as possible (in order to minimize exposures of drivers inside the tunnel).

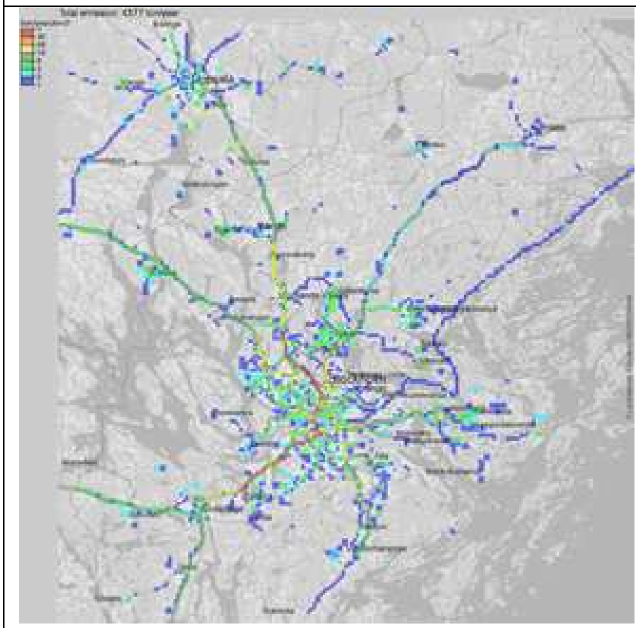
Other emissions than road traffic include combustion of fuels in small and large scale power plants, sea traffic and residential combustion of fuels. These emissions are assumed to be the same with or without the transit road.



NOx emissions 2030, without the transit road/tunnel (9141 t/y).



NOx emissions 2030, with the transit road/tunnel (9175 t/y).


PM10 emissions 2030, without the transit road/tunnel (4377 t/y).

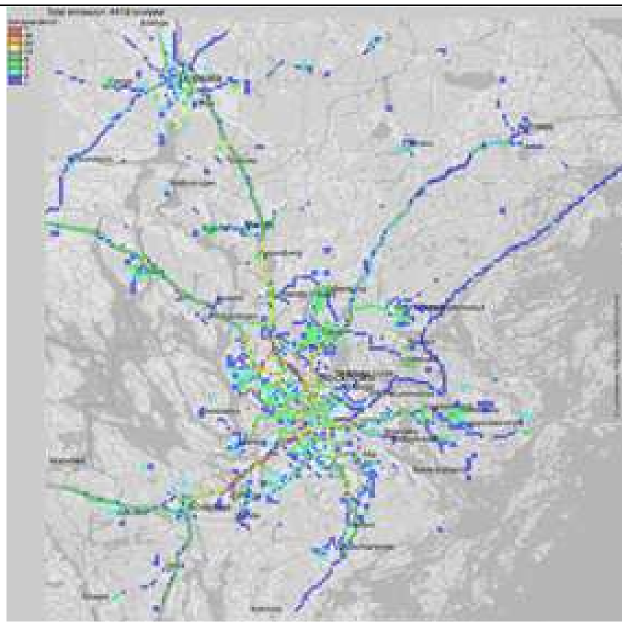

PM10 emissions 2030, with the transit road/tunnel (4419 t/y).

Fig. 18 Emissions of NOx and PM10 with wnd without the transit road in 2030.

The next section will discuss the downscaling results of these two future scenarios. It is important not only to compare them between themselves, but also to present conditions. Fig. 19 shows the trends of total NOx and PM10 emissions within the downscaling domain.

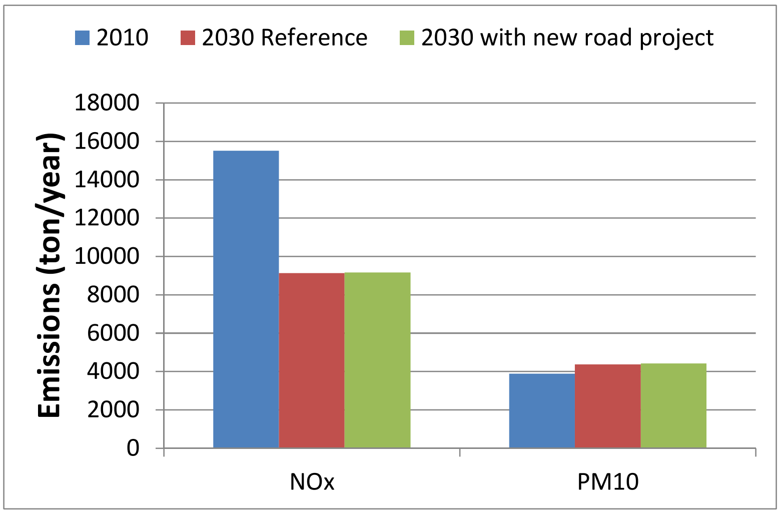


Fig. 19 Emissions for present (year 2010) and future (2030) conditions, using the two future Stockholm emission scenarios developed within WP5.

2.10. Activity 2.6.3.2 Grid model simulations of urban planning scenarios

Urban downscaling has been performed for the year 2030 with the two road transit scenarios and using the ECHAM5 A1B_3 scenario for the forcing and boundary conditions. The objective is to compare these two results with current (year 2010) conditions.

Fig. 20 shows the expected future urban background concentrations in city centre, i.e. at the site of the principal monitoring station. For comparison purposes we also show the effect of changes in air pollution concentrations of the air coming into Stockholm (green, taken from the results of Section 2.5).

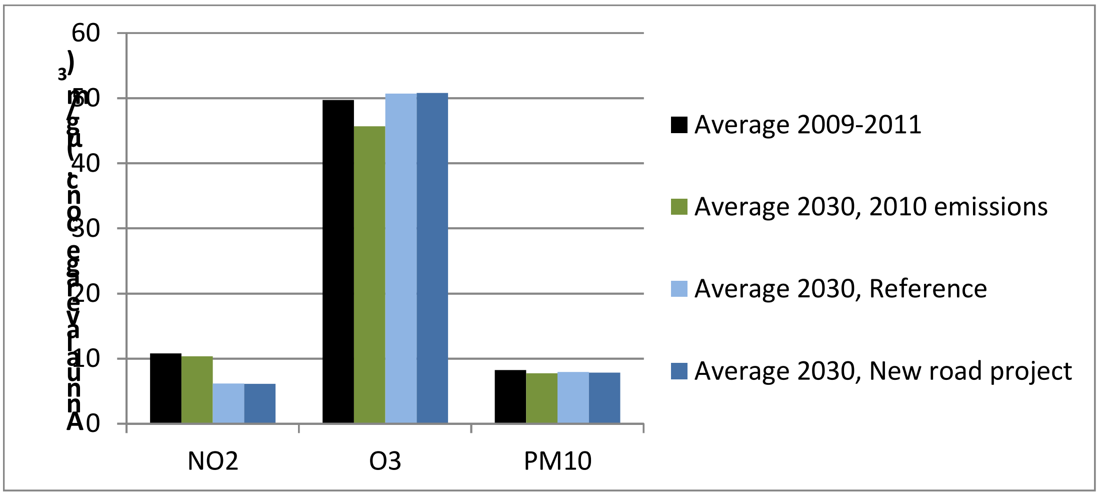


Fig. 20 Results of the downscaling of local emission scenarios, evaluating the effect of urban background concentrations in the city centre.

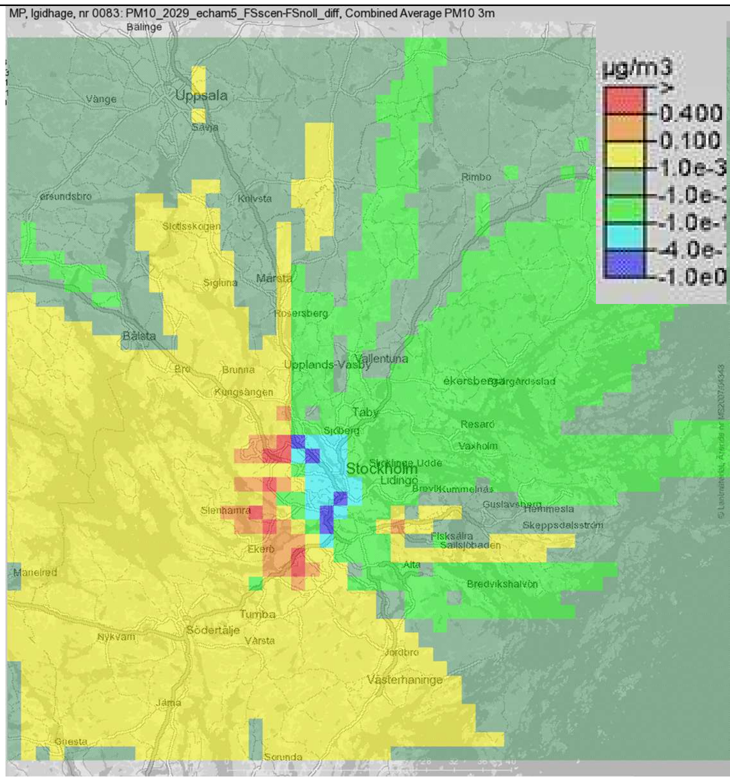
For NO2 the expected change to cleaner vehicles will significantly reduce the impact, meaning a substantial – of the order of 40% - reduction of NO2 levels in the urban background. However, there are indications from European studies that true emissions are larger than what the emission legislation requires, which means that the levels may not go down fully as much as indicated in Fig. 20.

For ozone there will likely not be a reduction in urban background concentrations, even if long range transport will contain some 10% less ozone. This is due to the lower NO emissions in the city, which will diminish the titration effect on ozone (the city being a sink for ozone).

For PM10, for which the long range transport contribution will go down slightly, there will a certain increased impact due increased local emissions. The reason behind is that traffic induced PM emissions are dominated by non-exhaust particles, mostly from road wear due to the use of studded tyres. There is a policy to decrease the use of studded tyres, but there are also traffic security reasons not to prohibit them. We have not considered a lower use of studded tyres in our future emission scenarios, in order to bring to decision makers the strong importance of road wear particles.

From Fig. 20 it is also clear that there is no significant change in impact of the two scenarios, as regard to typical city centre background concentrations. But if we look at the difference in concentration levels all over the downscaling domain (Fig. 21), it clear that the scenario with the new road project will increase pollution levels to the western part, while the city centre and the eastern part will have smaller reductions. Even if the differences are small, e.g. below one µgm^{-3}, which is small in percentage, it can have importance if a population weighted exposure is calculated. This is a future task within WP5.

Fig. 21 Results of the downscaling of local emission scenarios, evaluating the effect of urban background concentrations in the city centre.



3. Implemented Use Cases

The Stockholm pilot will demonstrate the use of Common Services with one application dealing with air quality and another with hydrological conditions. In total four use cases will be demonstrated (see Table 5). The last use case has however been changed during the V2 period (details given in Section 3.4 below).

Table 5 Overview of use-cases for Stockholm pilot definition plan V2.

Use-case	Part of Common Services	Objective
UC-511 "Visualise air quality model results"	Climate scenario information on the European scale & Air Quality Downscaling service	Visualise distribution and trends of air quality model results (European scale <u>or</u> downscaled over Stockholm)
UC-513 "Add monitor data to compare with model results"	Air Quality Downscaling service	Allowing model results and monitor data to be presented in the same graph, used to validate model output for historical periods
UC-521 "Execute air quality downscaling"	Air Quality Downscaling service	Start an air quality downscaling simulation over pilot city area
UC-531 "Local 3D model execution"	Air Quality Downscaling service	Start an air quality downscaling simulation over a part of the pilot city area, i.e. perform the urban downscaling twice and with the last one with very high spatial resolution.

3.1. UC-511 Visualise air quality model results

This use case has been demonstrated in Section 2.1. The pilot conclude that the current version works according to expectations and that it provides valuable information concerning the expected evolution of climate and long range air pollutants coming to Stockholm. It should be noted that some of the extension are still not implemented. The use case UC-811 includes five extensions:

Extensions	
3a	The user can change the time point of the simulation currently shown in the map.
3b	The user can set the colour scale of the pollutant distribution.

3c1	If the user clicks in the map a time-series diagram will be presented for the specific location. The diagram shows the pollutants concentration over the complete time of the simulation. The current position time point viewed in the map will be indicated in the diagram.
3c2	Export visualised model or monitor time series to other formats (Excel etc.)
3d	Export visualised model grid results in other formats (Excel etc.)

Extensions 3b, 3c2 and 3d are still not implemented and will be demonstrated in V3. For 3c1 the current version allows 10-year averages to be visualised, later version should allow also annual, monthly and daily values to be visualized (and exported).

3.2. UC-513 Add monitor data to compare with model results

This use case is awaiting the implementation of a SMS import functionality, expected during the beginning of V3.

3.3. UC-521 Execute air quality downscaling

The full implementation of CS functionality in the SMS user interface is still not concluded. For the WP5 pilot this is not hindering the exploitation of the Common Services, since this particular part of SMS functionality is also found in an external web-based user interface, Airviro. The results generated by the SUDPLAN Common Services AQ downscaling are exemplified in Section 2.4, 2.5 and 2.10.

3.4. UC-531 Local 3D model execution

When D5.1.2 Stockholm Pilot Definition Plan V2 was submitted (March 2011), the plan was to create a specific SMS system for Stockholm, with an user interface that allowed local model execution. During discussions between WP3, WP4 and WP5 it was later decided to avoid the implementation of a specific SMS for Stockholm and the use case UC-531. Since Stockholm and Prague are basically demonstrating the use of Common Services that will be accessible for whatever city in Europe, we decided to reformulate this use case.

Instead of actually executing local models (which SULVF already do through Airviro), we decided to elaborate a SMS service for importing certain type of air quality results produced by local models, to be visualised through the SMS advanced 3D component. These are road link data (Section 2.8), 2D and 3D output from grid models (Section 2.6).

With this the SMS air quality functionality will be general for all cities in Europe and results from a variety of local models can be taken into the SMS platform.

In D5.1.3 Stockholm Pilot Definition Plan V3, the UC-531 will be renamed to “Import of local model results with the aim of advanced visualisation”.

4. Conclusions

Stockholm pilot activities and use-cases have been defined in the D5.1.2 Pilot Definition Plan V2 for Stockholm. Good progress has been achieved for the experimentation of Common Services air quality downscaling. Scenario results for 2030, for different transit road solutions, are already now of interest for city planners. The SUDPLAN tools have been presented to two external end users that are responsible for the environmental consequences of a planned road transit solution. The two environmental experts have committed to participate in pilot validation and will provide the required external feedback for aspects of AQ to the SUDPLAN development team.

In summary the air quality downscaling work has generated substantial results that are already useful for the long term plan "Stockholm Vision 2030". More substantial progress in the visualisation will take place during the first half of 2012.

5. References

D4.4.1 Air Quality Downscaling Service V1

D5.1.1 Stockholm Pilot Definition Plan

André, M. and Rapone, M., 2009: Analysis and modelling of the pollutant emissions from European cars regarding the driving characteristics and test cycles. Atmospheric Environment 43, 986-995.

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Gidhagen, L., Johansson, C., Omstedt, G., Langner, J. and Olivares, G., 2004: Model simulations of NOx and ultrafine particles close to a Swedish highway, Environmental Science and Technology 38, 6730–6740.

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Langner, J., Engardt, M. and Andersson, C., 2012: European surface ozone 1990-2100. Manuscript in preparation.

6. Glossary

Climate scenario	*Climate scenarios* means the resulting climate evolution over time, as simulated by global (GCMs) and regional (RCMs) climate models. Climate scenarios are products of certain emission scenarios that reflect different economic growth and emission mitigation agreements.
Common Services	*Common Services* is the climate downscaling services for rainfall, river flooding and air quality, developed in the SUDPLAN project and accessed through the SUDPLAN platform (Scenario Management System)
Common Services server	*Common Services* models will be executed at a SMHI server, accessible through OGC communication.
Emission scenario	These are of three types, of which the first one is behind the climate scenarios used in all SUDPLAN Common Services. The two remaining emission scenario types are only relevant for air quality downscaling.
- *IPCC emission scenarios*	*IPCC emission scenarios* are estimates of future global greenhouse gas concentrations based on assumptions about global development (economic growth, technical development, mitigation agreements, etc). During the first two years of the SUDPLAN projects, the climates scenarios based on SRES (Special Report on Emission Scenarios) A1B scenario from the 4th assessment have been used. The SRES emission scenarios do not include emissions of the pollutants of interest for air quality. If available the climate scenarios based on the 5th assessment RCP (Representative Concentration Pathways) emissions scenarios will also be used within the SUDPLAN project. They include emissions of air pollutants.
- *European tracer gas emissions (air pollutants)*	*European tracer gas emissions (air pollutants)* thus may or may not be included in IPCC emission scenarios. For creating Pan-European air quality fields under climate scenarios driven by the SRES A1B emission scenario, SUDPLAN uses tracer gas emissions from the more recent RCP emission scenarios. This inconsistency will be solved when climate scenarios based on RCP emission scenarios are available.

- *Local emission scenarios*	*Local emission scenarios* (to the atmosphere) are those of a particular European city. These will to a large extent influence future air quality in the city, but have little influence on global climate, nor do they influence air pollution concentrations in incoming long-range transported air. SUDPLAN will typically need gridded emissions with 1x1 km or finer spatial resolution as input to its urban air quality downscaling model.
Information product	Raw data, such as the results of mathematical modelling, and the analysis thereof, will often need to be packaged in such a way as to be accessible to the various stakeholders of an analysis. The medium can be one of a wide variety, such as print, photo, video, slides, or web pages. The term *information product* refers to such an entity.
Model	A *model* is a simplified representation of a system, usually intended to facilitate analysis of the system through manipulation of the model. In the SUDPLAN context the term can be used to refer to mathematical models of processes or spatial models of geographical entities.
PM_{10}	'PM10' shall mean particulate matter which passes through a size-selective inlet as defined in the reference method for the sampling and measurement of PM10, EN 12341, with a 50 % efficiency cut-off at 10 μm aerodynamic diameter;
$PM_{2.5}$	'PM2,5' shall mean particulate matter which passes through a size-selective inlet as defined in the reference method for the sampling and measurement of PM2,5, EN 14907, with a 50 % efficiency cut-off at 2,5 μm aerodynamic diameter;
Profile	Within SUDPLAN a *profile* is a set of configuration parameters which are associated with an individual or group, and which are remembered in order to facilitate repeated use of the system.
Regional downscaling	A climate scenario may be downscaled to a higher spatial resolution, typically 25-50 km, by a Regional Climate Model (RCM). The regional downscaling in SUDPLAN will be performed by SMHI's RCM (RCA, see below) and will generate climate scenarios at 44 or 22 km resolution.

Report	A *report* is a particular type of information product which is usually static and might integrate still images, static data representations, mathematical expressions, and narrative to communicate an analytical result to others.
Scenario	A *scenario* is a set of parameters, variables and other conditions which represent a hypothetical situation, and which can be analysed through the use of models in order to produce hypothetical outcomes. In SUDPLAN a scenario is an individual model simulation outcome to be used in urban planning. The model simulation may or may not include Common Services downscaling (with specific input) and may or may not include a local model simulation (with specific input and parameters).
Scenario Management System	*Scenario Management System* is synonymous with SUDPLAN platform
Scenario Management System Framework	The *Scenario Management System Framework* is the main Building Block of the Scenario Management System. It provides the Scenario Management System core functionalities and integration support for the other Building Blocks.
Scenario Management System Building Block	Scenario Management System Framework is composed of three distinct *Building Blocks*: The Scenario Management System Framework, the Model as a Service Building Block and the Advanced Visualisation Building Block.
SUDPLAN application	A *SUDPLAN application* is a decision support system crafted by using the SUDPLAN platform and integrating models, data, sensors, and other services to meet the requirements of the particular application.
SUDPLAN platform	The *SUDPLAN platform* is an ensemble of software components which support the development of SUDPLAN applications.
SUDPLAN system	*SUDPLAN system* is synonymous with SUDPLAN application

Urban downscaling	This refers to further downscaling of the regional climate scenarios for Europe to the urban scale within SUDPLAN. This will be possible for a) *rainfall/precipitation* where the temporal resolution will be 30 minutes or less. The spatial resolution will be that of a precipitation gauge, i.e. representative for a point rather than a certain area. b) *hydrological variables (river runoff, soil moisture etc*) where the temporal resolution is daily and the spatial resolution linked to catchment areas which presently count approximately 35000 and with average size 240 km^2. *c) air quality (PM, NO2/NOx, SO2, O3, CO).* The temporal resolution will be hourly for gridded output fields and the spatial resolution typically 1x1 kilometres.
User	The term *user* refers to people who have a more or less direct involvement with a system. Primary users are directly and frequently involved, while secondary users may interact with the system only occasionally or through an intermediary. Tertiary users may not interact with the system but have a direct interest in the performance of the system.
Web-based	Computer applications are said to be *web-based* if they rely on or take advantage of data and/or services which are accessible via the World Wide Web using the Internet.

7. Acronyms and Abbreviations

Acronym	Description
ACIDD	Association of Communication and Information for sustainable Development
Airviro	Air quality management system to facilitate data collection, emission inventories etc, see http://www.airviro.smhi.se/
CS	Common Services
AVDB	Airviro Time Series database (used for storage in Common Services)
AR4, AR5	Fourth and Fifth Assessment Report of IPCC
AQ	Air Quality
C API	Application Programming Interface written in C

CMIP5	Coupled Model Intercomparison Project, phase 5 (coordinated model exercise in support to AR5)
CS	Common Services (SUDPLAN functionality)
CTM	Chemistry Transport Model
CTREE	FairCom CTREE database (Index database, core of AVDB)
DBS	Distribution-Based Scaling, a method to bias-correct (i.e. remove systematic errors in) the temperature and precipitation of the RCM output
DoW	SUDPLAN Description of Work
DSS	Decision Support Systems
ECHAM5	GCM developed at Max Planck Institute for Meteorology, DE
ECMWF	The European Centre for Medium-Range Weather Forecasts (also co-ordinating FP7-SPACE project MACC)
EDB	Airviro Emission database
EEA	European Economic Association
E-HYPE	HYdrological Predictions for the Environment (European set-up), hydrological rainfall-runoff model developed and used by SMHI
EM&S	Environmental Modelling and Software
ESA	European Space Agency
ESDI	European Spatial Data Infrastructure
EU	European Union
GCM	Global Climate Model or, equivalently, General Circulation Model. Physically based computer model that simulates the global climate on a 200-300 km resolution. Can be used both to reproduce historical climate and estimate future climate, e.g. in response to changes in greenhouse gas concentrations.
GTE	Georeferenced Time-series Editor
GIS	Geographic Information System
HadCM3	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 Technologies
ID	Identifier
IDF-curve	Intensity Duration Frequency-curve, a curve (or a table of values) showing the rainfall intensity associated with a certain duration (i.e. time period) and frequency (i.e. probability, generally expressed as a return period). Calculated from short-term rainfall observations and widely used in design of urban drainage systems.
iEMSs	International Environmental Modelling & Software Society
IFIP	International Federation for Information Processing
IPCC	The Intergovernmental Panel on Climate Change, the leading body for the assessment of climate change
IPR	Intellectual Property Rights

ISAM	Indexed Sequential Access Method, a method for indexing data for fast retrieval
ISO	International Standardization Organisation
ISESS	International Symposium on Environmental Software Systems
IST	Information Society Technology
MATCH	Multiple-scale Atmospheric Transport and Chemistry modelling system, a CTM developed and used by SMHI.
MODSIM	International Congress on Modelling and Simulation
OASIS	1) Organization for the Advancement of Structured Information Standards 2) Open Advanced System for Disaster and Emergency Management (FP6 project)
OGC	Open Geospatial Consortium
O&M	Observation and Measurements
ORCHESTRA	Open Architecture and Spatial Data Infrastructure in Europe (FP6 IST-511678)
OSGeo	Open Source Geospatial Foundation
OSIRIS	Open architecture for Smart and Interoperable networks in Risk management based on In-situ Sensors (FP6 IST-33799)
PMC	Project Management Committee
RC	Rossby Centre, climate research unit at SMHI
RCA	Rossby Centre Atmospheric model, RCM developed by SMHI and used in SUDPLAN
RCM	Regional Climate Model, commonly used to increase the spatial resolution of climate scenarios to 25-50 km in a specific region.
RNB	Airviro Field database
SANY	Sensors Anywhere (FP6 IST-033654)
SDI	Spatial Data Infrastructure
SISE	Single Information Space in Europe for the Environment
SMHI	Swedish Meteorological and Hydrological Institute
SMS	Scenario Management System
SOA	Service Oriented Architecture
SOS	Sensor Observation Service
SPS	Sensor Planning Service
SWE	Sensor Web Enablement
SUDPLAN	SUDPLAN Sensors Anywhere (FP6 integrated project)
SWE	Sensor Web Enablement
Tbd	To be determined
UWEDAT	AIT environmental data management and monitoring system
WCC	World Computer Congress
WCS	Web Coverage Service
WFS	Web Feature Service

WP	Work Package
WPS	Web Processing Service
WMS	Web Map Service

8. 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.

9. 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.