

Web Services for Incorporation of Air Quality and Climate Change in Long-Term Urban Planning for Europe

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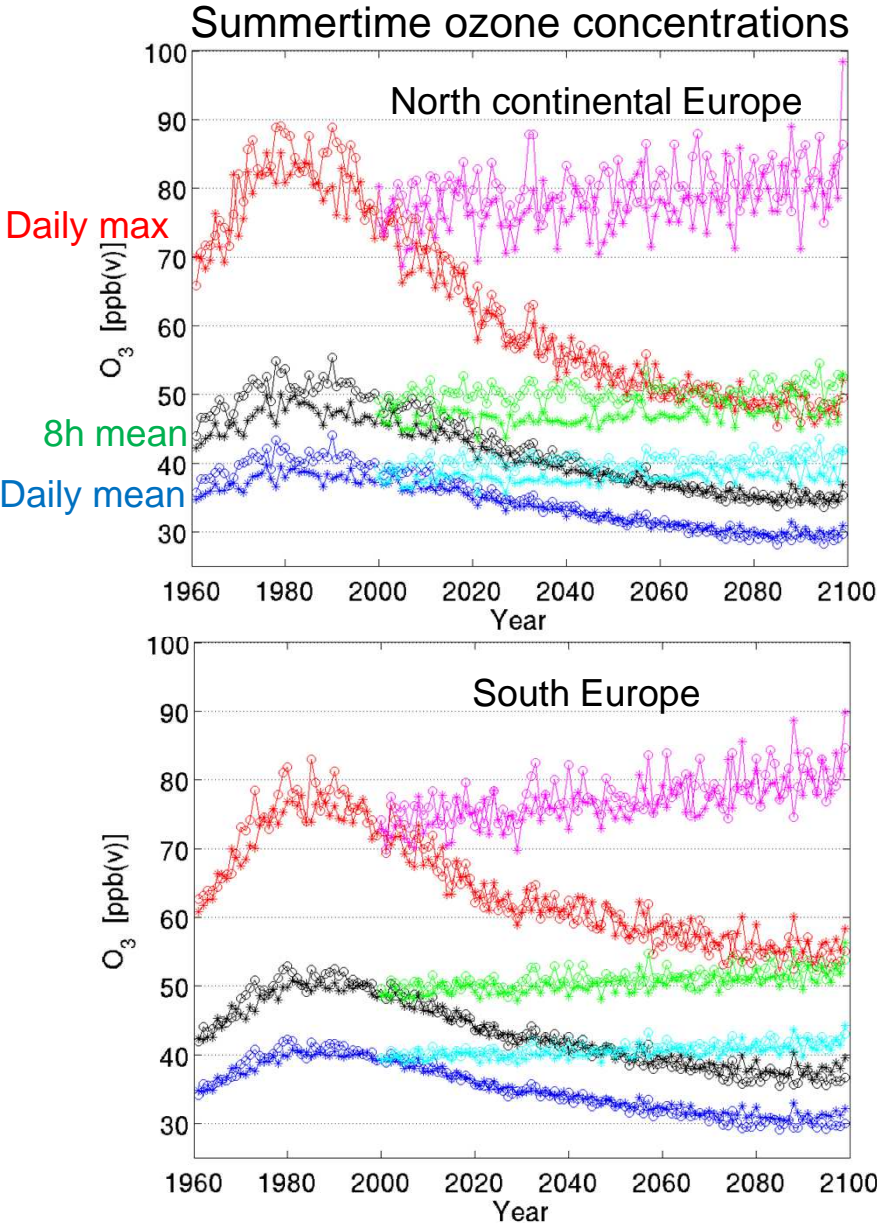
²Stockholm Environment and Health Administration

Environmental information for long term urban planning must consider climate change



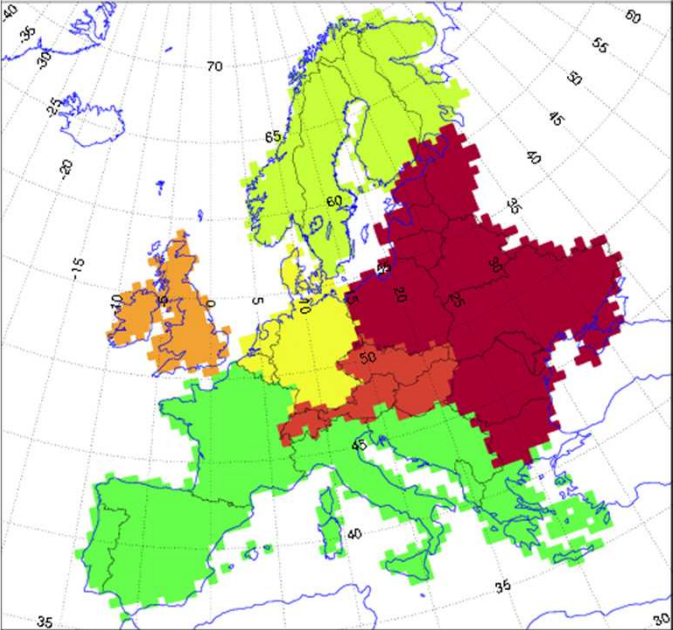
Various factors will influence future air quality in a 20-30 year perspective

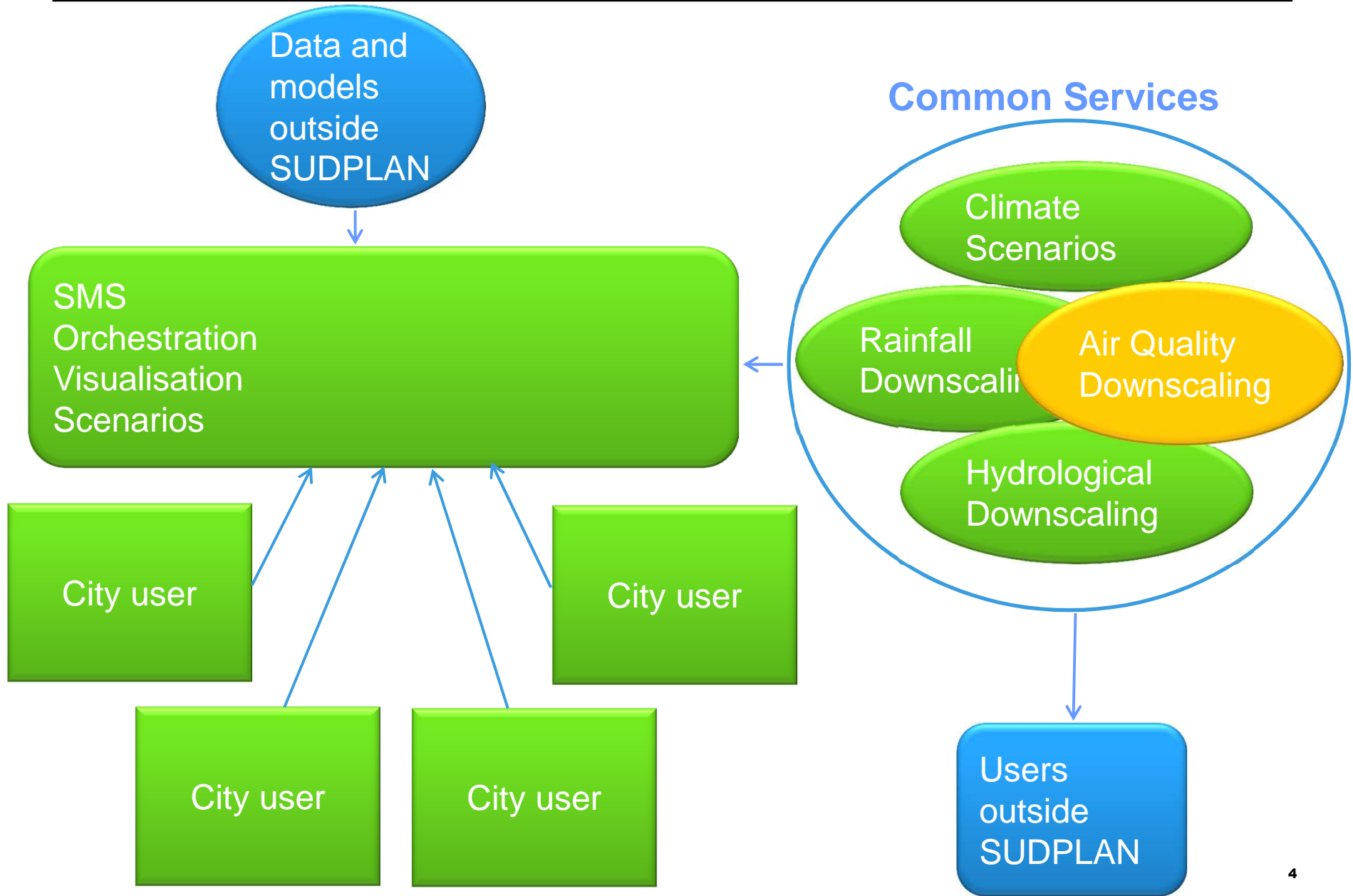
- **Locally:** City population growth, design of transportation and energy production systems
- **Europe:** EU efforts to mitigate pollutant emissions
- **Worldwide:** Global background levels, atmospheric chemistry



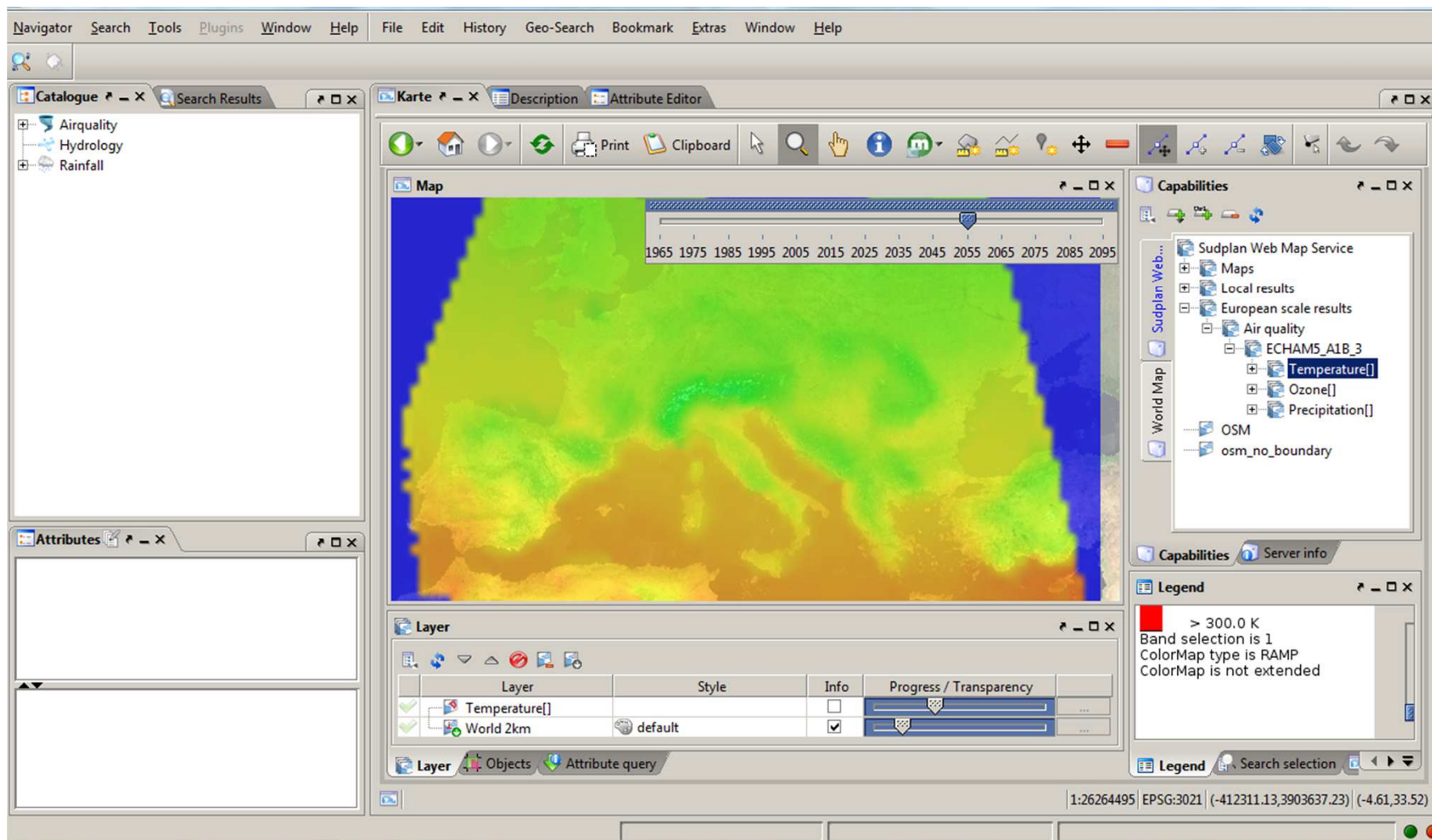
What is the expected impact of
a) climate change alone?
b) combination of climate change and changes in European tracer emissions?

Simulated on the European scale with two different climate scenarios as forcing and with RCP4.5 emission development switched on and off





Climate and air quality levels on the European scale based on a selected number of climate model results



Common Services added information for each climate scenario

These results are on the European scale, either as hindcast or as climate scenarios						
Grids are stored in Airviro database, watershed data in HOMER, time resolution (O) can be displayed over map (SMS)						
Pointwise time series with time resolution (X) can be downloaded to client (SMS)						
	Spatial data			Output time series in receptor point		
Parameter	type	size	10-year	year	month	day
Temperature (uncorrected)	grid	44x44 km	O	X	X	X
Precipitation (uncorrected)	grid	44x44 km	O	X	X	X
Temperature (corrected)	watershed	"15x15 km"	O	X	X	X
Precipitation (corrected)	watershed	"15x15 km"	O	X	X	X
Mean Q (ackumulated runoff)	watershed	"15x15 km"	O	X	X	X
Local runoff	watershed	"15x15 km"	O	X	X	X
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	

Urban planning require information on a higher spatial scale and with inclusion of local emission scenarios

Vision for Stockholm 2030
growth & sustainable development

- 150 000 more citizens
- Denser city
- Fossil free 2050
- Recycling of waste
- Green belts
- Sustainable housing and workplace areas



Urban Scenario Evaluation:

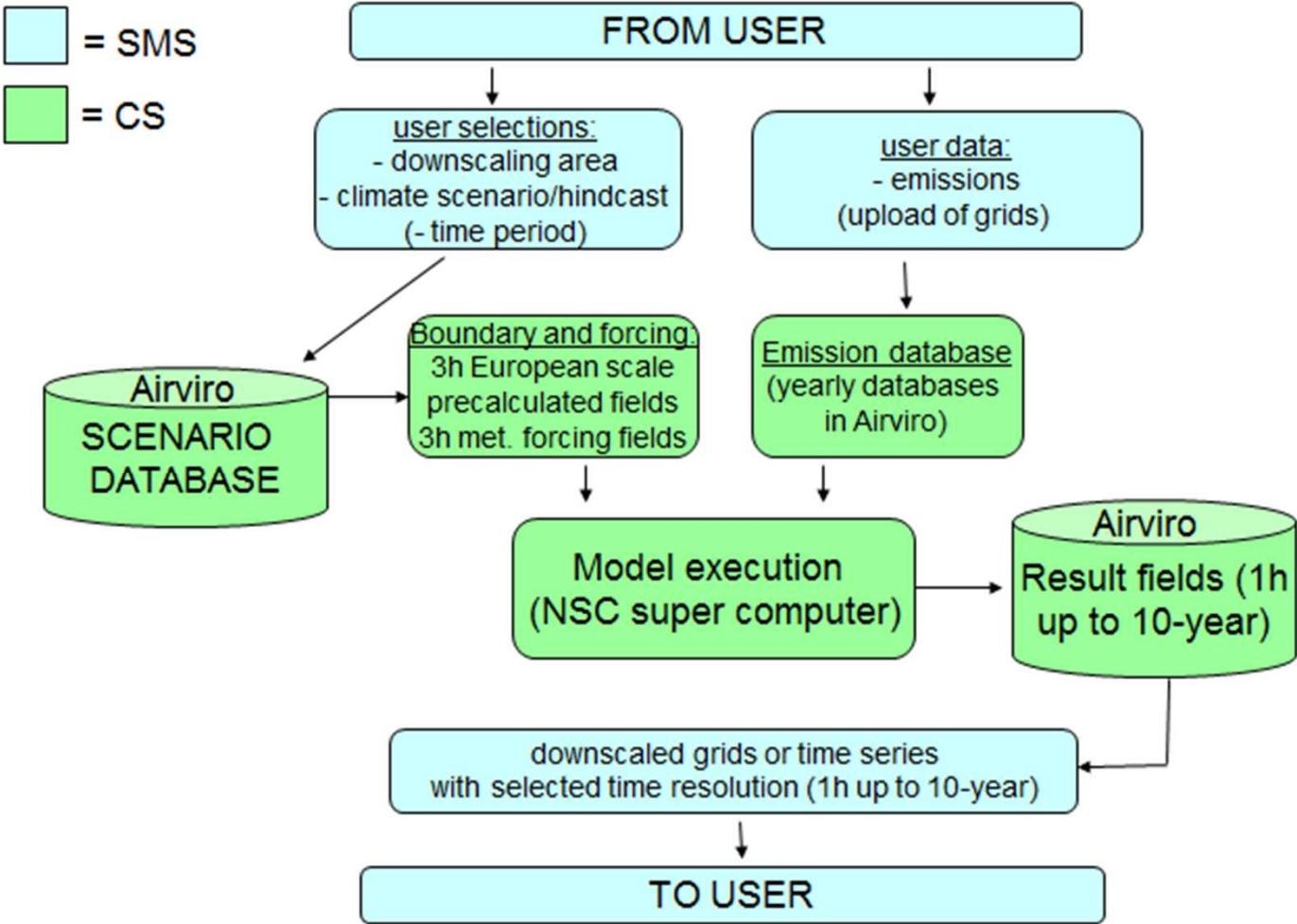
Comparison of two proposed traffic solutions bypassing Stockholm

- Connect north and south
- Provide efficient ways to pass the city
- Increase possibility for creating new residential areas and commercial centers

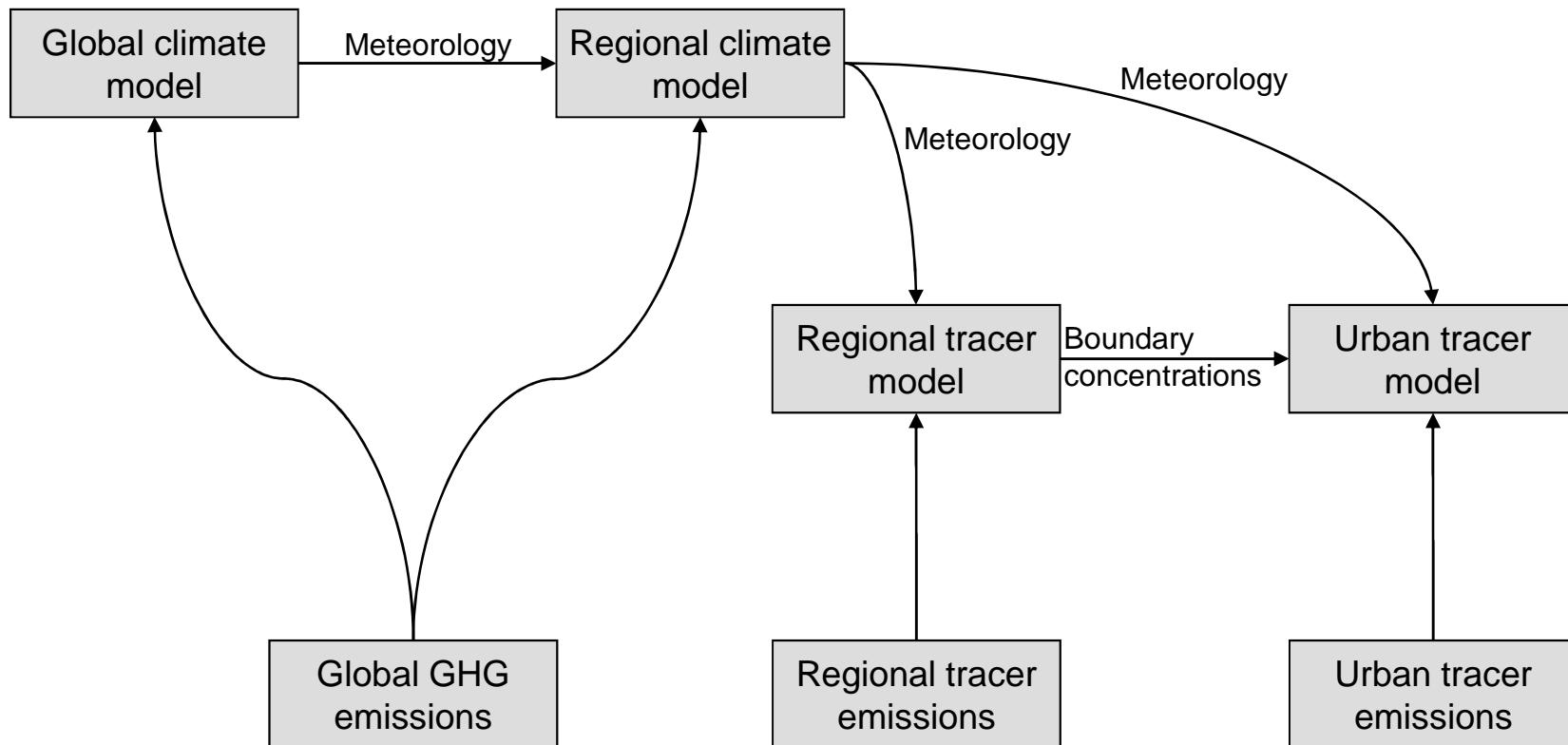


User input: Emissions NO_x, NH₃, VOC, SO₂, CO and PM10

Output: Concentration levels of NO_x/NO₂, O₃, SO₂ and PM10



Nesting of air quality models

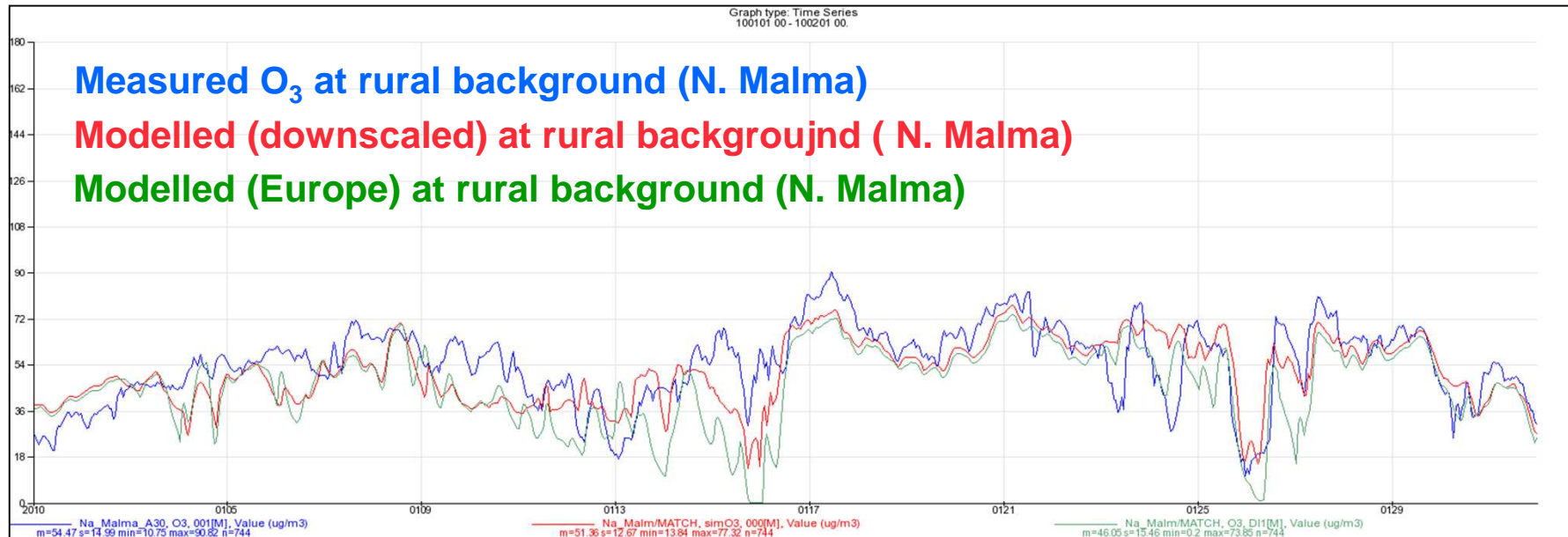
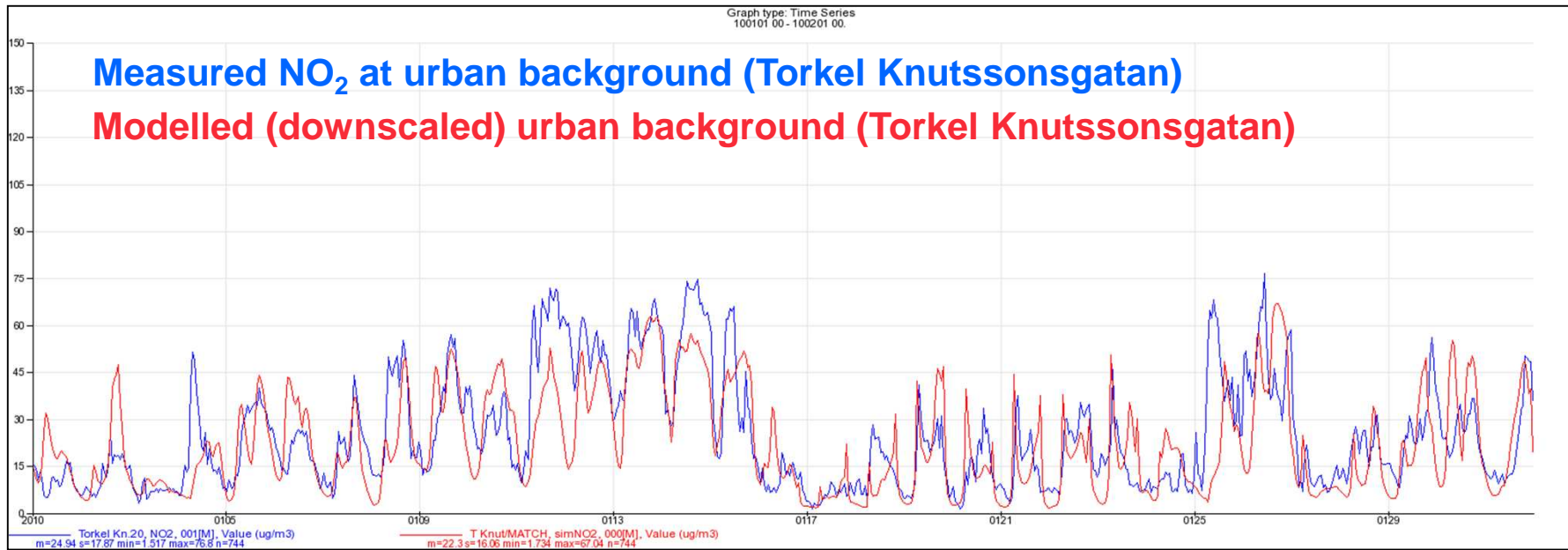


Air quality model evaluation

- Run model with observed meteorology for a recent period. Use emissions valid for that period. Compare hour-to-hour with observations.
- Run model with meteorology from a climate model simulating a recent period. Use emissions valid for that period. Compare averages with observations

Hour-to-hour January 2010

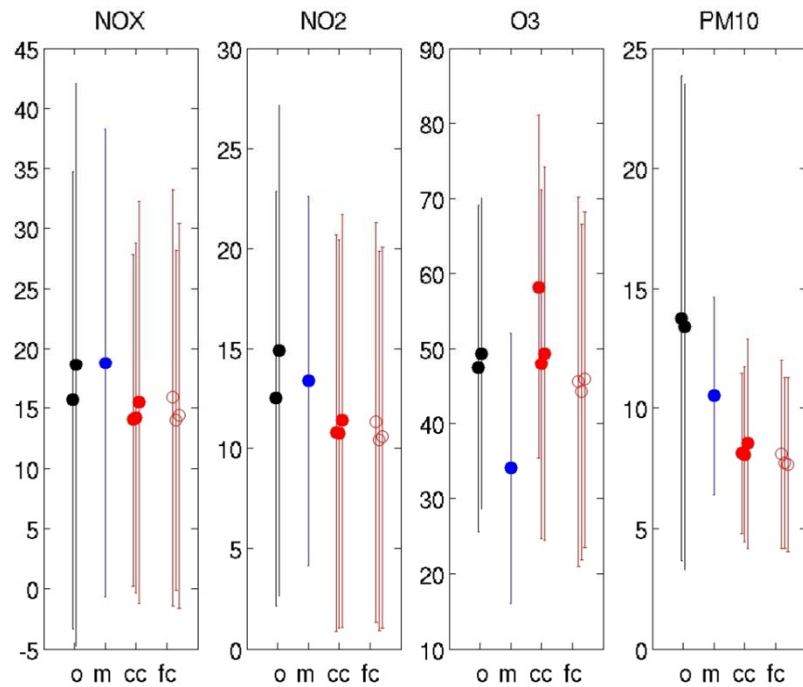
SUDPLAN



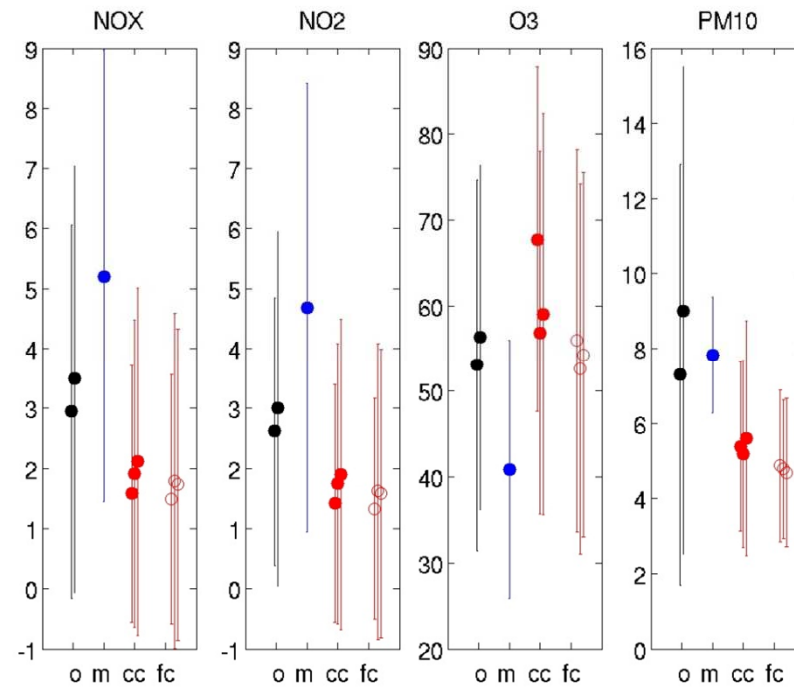
Comparison of annual averages

- Measured (2009 and 2010)
- Modelled-Stockholm (current climate, ~2010)
- Modelled-Europe (2010)
- Modelled-Stockholm (future climate, ~2030)

Urban background

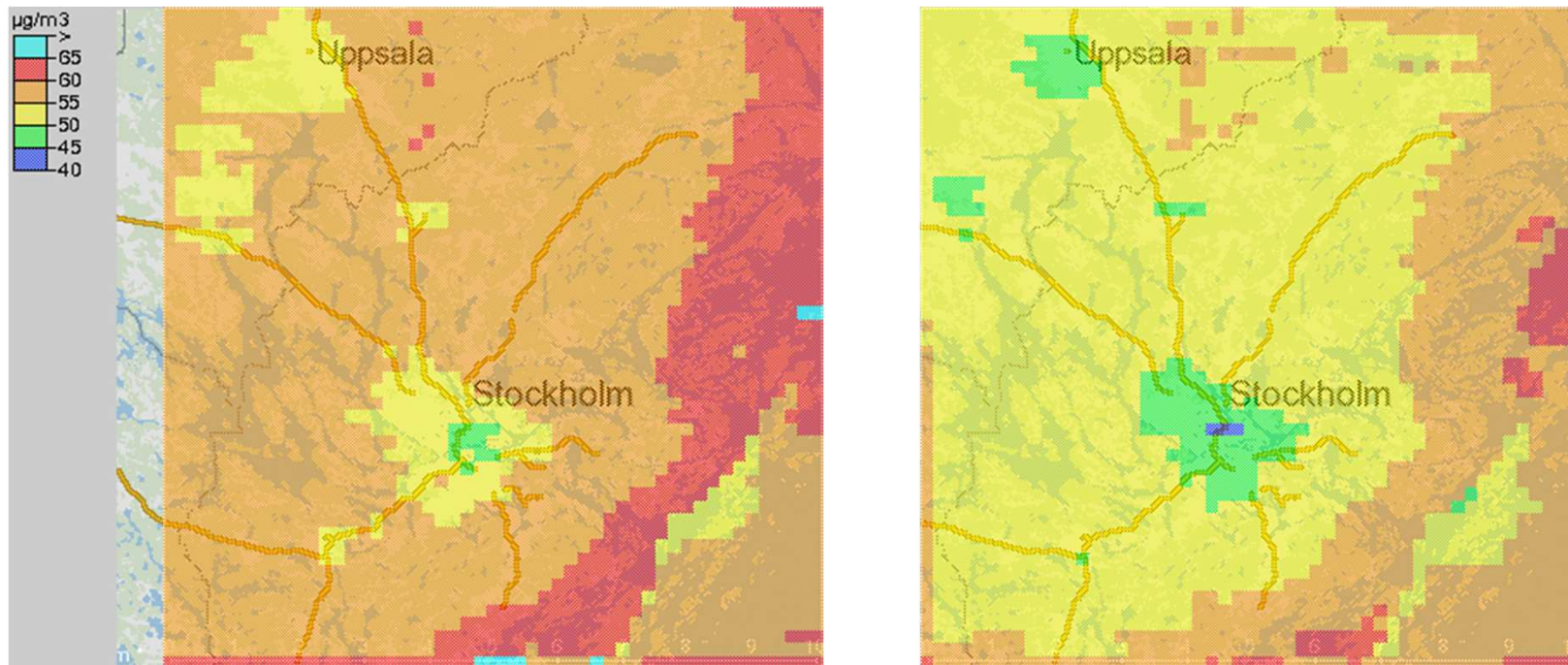


Rural background



~2010

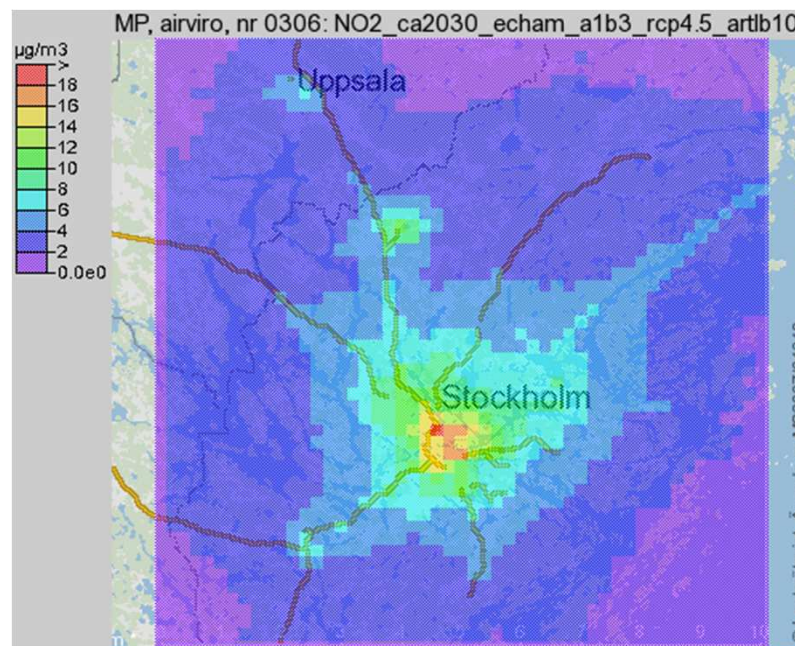
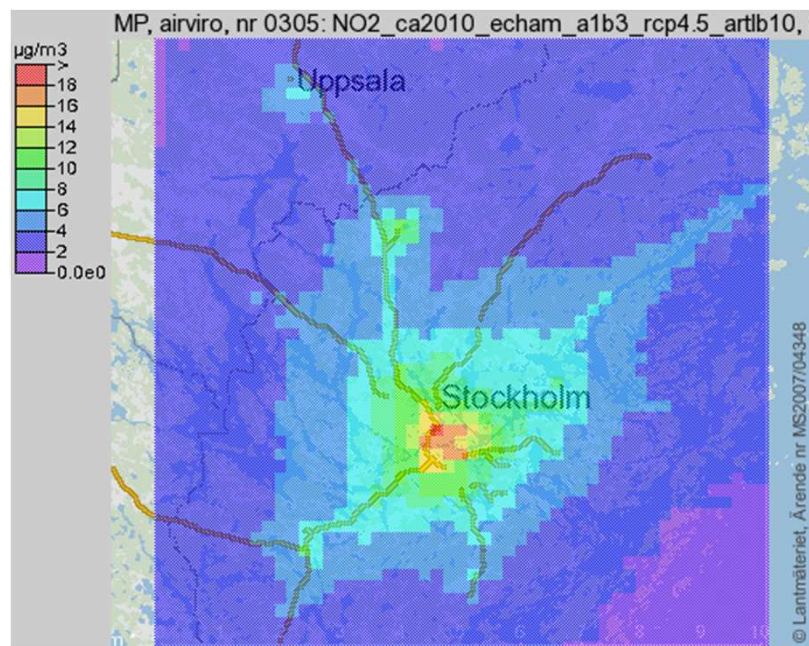
~2030



3-year average O₃ concentration (ca. 2010 left, ca. 2030 right). The panels depict a situation where the local emissions were kept at the levels of 2010, but climate were changing according to the ECHAM A1B scenario and European tracer emissions following RCP4.5.

~2010

~2030



3-year average NO₂ concentration (ca. 2010 left, ca. 2030 right). The panels depict a situation where the local emissions were kept at the levels of 2010, but climate were changing according to the ECHAM A1B scenario and European tracer emissions following RCP4.5.

Common Services output for each climate scenario

These data are generated through SUDPLAN downscaling.

Grids are stored in Airviro database, time resolution (X) can be displayed over map (SMS)

Pointwise time series with time resolution (X) can be downloaded to client (SMS)

Parameter	Spatial data						Output time series in receptor point			
	type	10-year	year	month	day	hour	year	month	day	hour
NO2	grid	X	X	X	X	X	X	X	X	X
NOx	grid	X	X	X	X	X	X	X	X	X
SO2	grid	X	X	X	X	X	X	X	X	X
PM10	grid	X	X	X	X	X	X	X	X	X
O3	grid	X	X	X	X	X	X	X	X	X

hourly data only for short (<1 year simulations)

- The SUDPLAN Scenario Management System, together with its Common Services, allow downscaling of air quality for whatever European city. Required input from end-user are gridded emissions (annual averages)
- In the SUDPLAN approach we "nest" urban models with European scale models simulating future air quality, taking into account climate and emissions changes
- An "ensemble" of simulations provides a measure of uncertainty for the climate change and the development of European tracer emissions.
- The effects of climate change and reduced European emissions have been studied separately. For ozone, concentrations will decrease due to emission reductions, although climate change will partly mitigate this.
- The performance of the Common Services air quality downscaling has been evaluated for the European domain and the Stockholm area:
 - NO_x and O₃ works well
 - PM₁₀ is underestimated due to omission of some sources (work is underway to remedy this)

Thank you for your attention!

SUDPLAN

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<http://www.suplan.eu/>

Partners

1. Swedish Meteorological and Hydrological Institute
2. Austrian Institute of Technology
3. cismet GmbH
4. Czech Environmental Information Agency
5. Apertum IT AB
6. Deutsches Forschungszentrum für Künstliche Intelligenz
7. Stockholm Uppsala Air Quality Management Association
8. City of Wuppertal
9. Technische Universität Graz

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APERTUM

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