Uncertainties in future air quality: a scientific workflow tool

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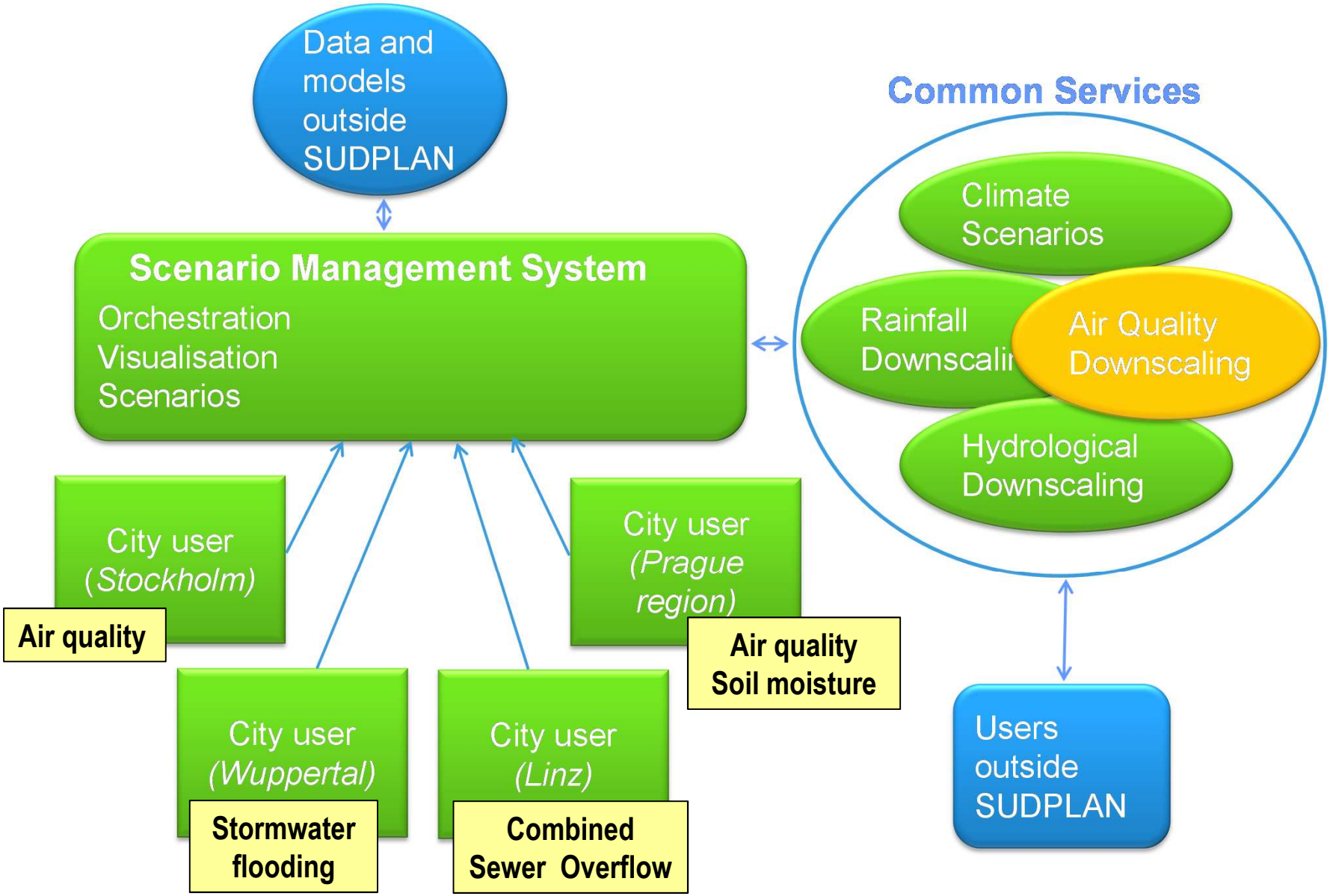
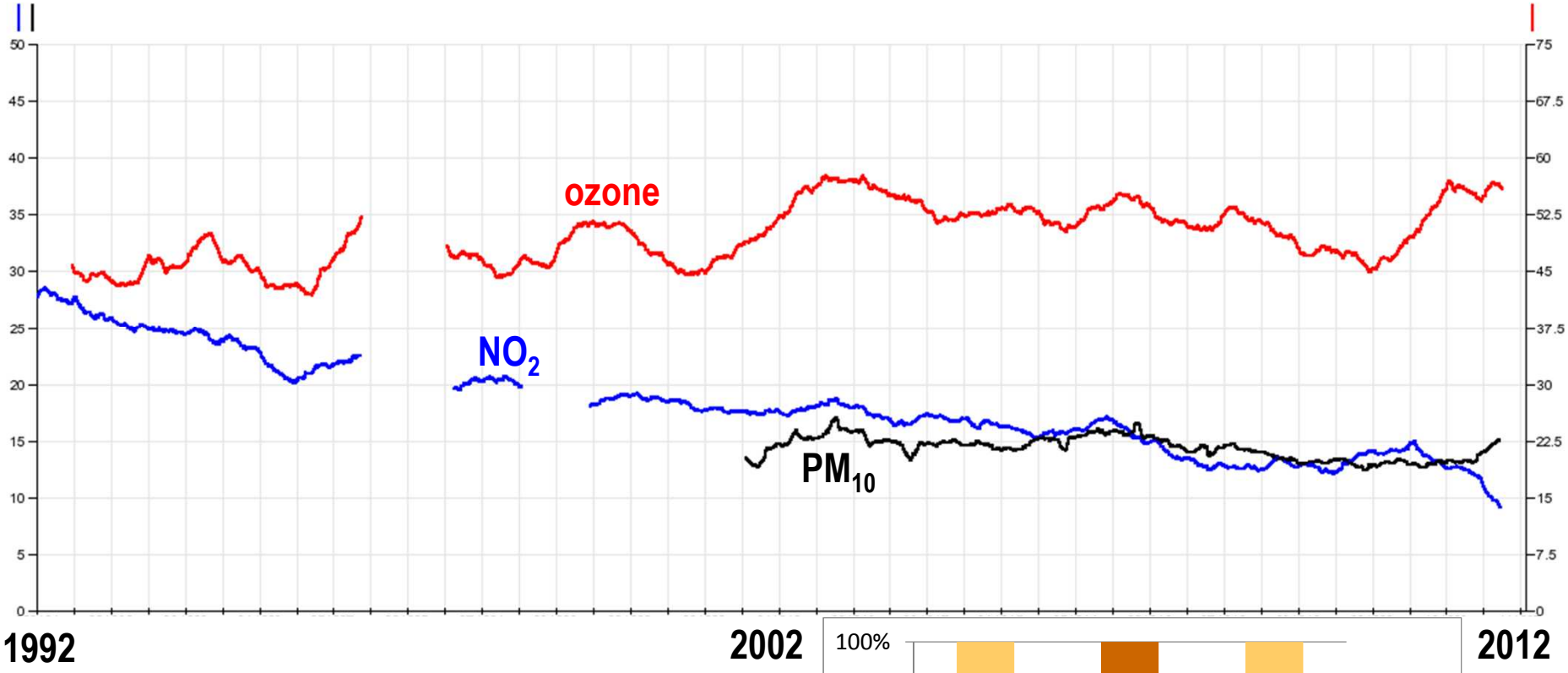
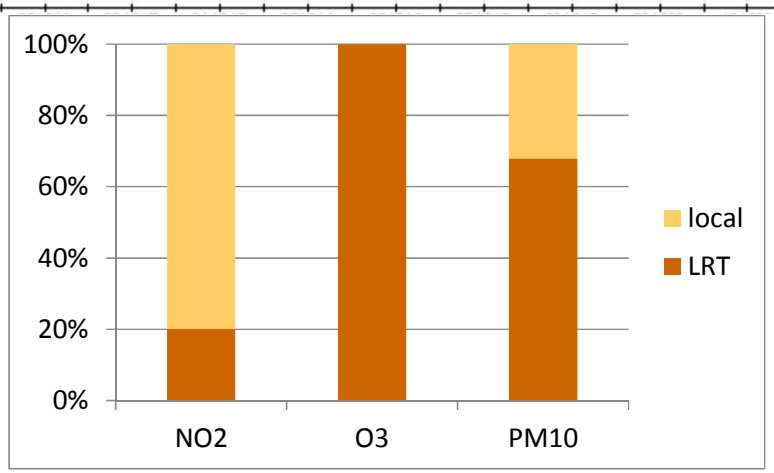

Data and models outside SUDPLAN
Common Services
Climate Scenarios
Rainfall Downscaling
Air Quality Downscaling
Hydrological Downscaling
Scenario Management System
Orchestration
Visualisation
Scenarios
City user (Stockholm)
Air quality
City user (Prague region)
Air quality
Soil moisture
City user (Wuppertal)
Stormwater flooding
City user (Linz)
Combined Sewer Overflow
Users outside SUDPLAN

Trends in Stockholm urban background concentrations



Important to separate:

- long range transported part
- impact of local emissions



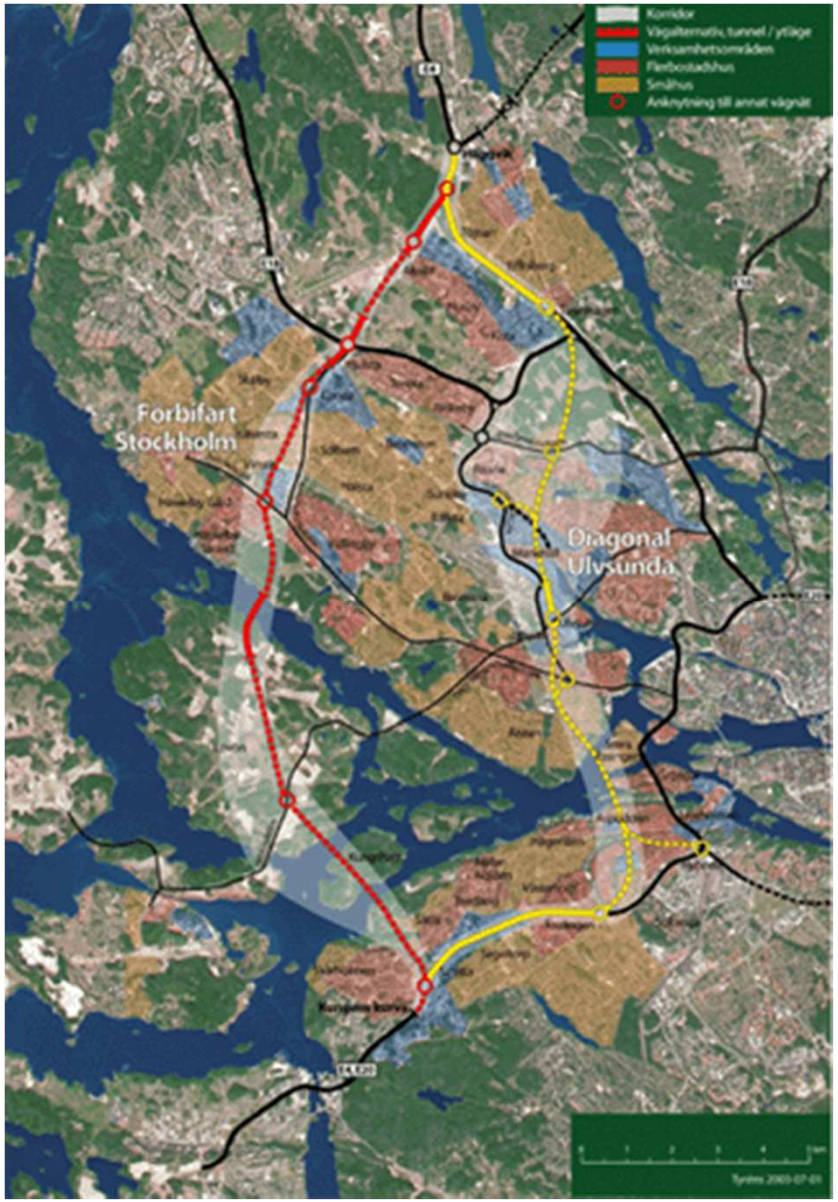
Vision for Stockholm 2030

growth & sustainable development

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

New transit road ~2025

- 21 km road west of city centre
- 18 km in tunnel



1. Climate change effects on air quality

2. Changes in anthropogenic emissions outside Stockholm

3. Changes in local emissions within Stockholm

SUDPLAN handles this by:

1. Using various GCM output (e.g. ECHAM5 A1B, HADLEY A1B, regionally downscaled over Europe with SMHIs RCA3 model).

2. Using different anthropogenic emission scenarios (e.g. RCP4.5 time varying, RCP4.5 fixed at year 2000 level)

3. Using detailed scenarios for local emissions (e.g. with and without road transit project)

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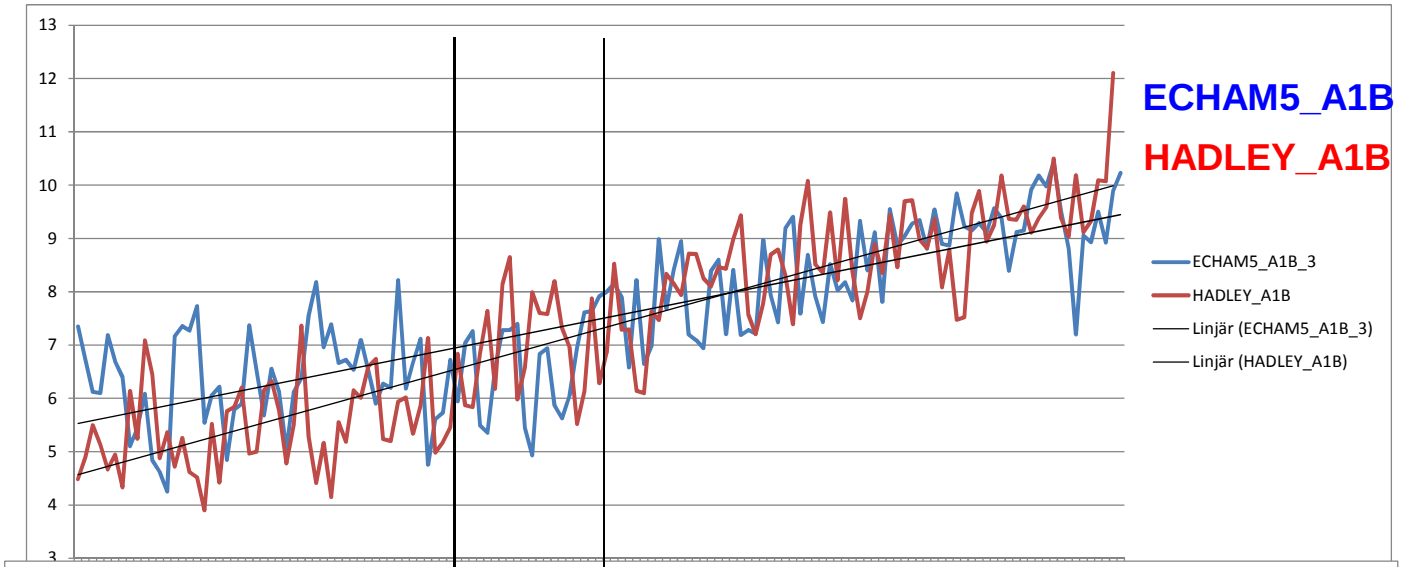
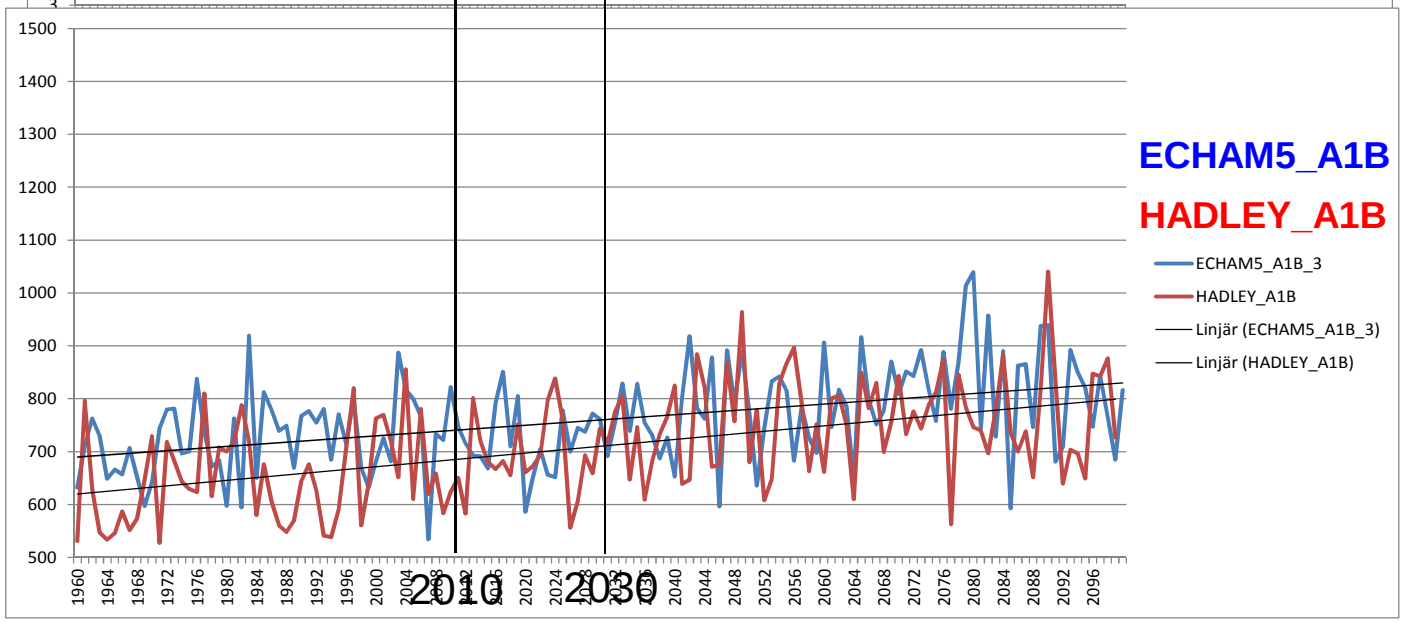
Temperature and precipitation in Stockholm 1960-2100 (change 2010-2030)

Temperature:
~ 0.6-0.8 °C
warmer

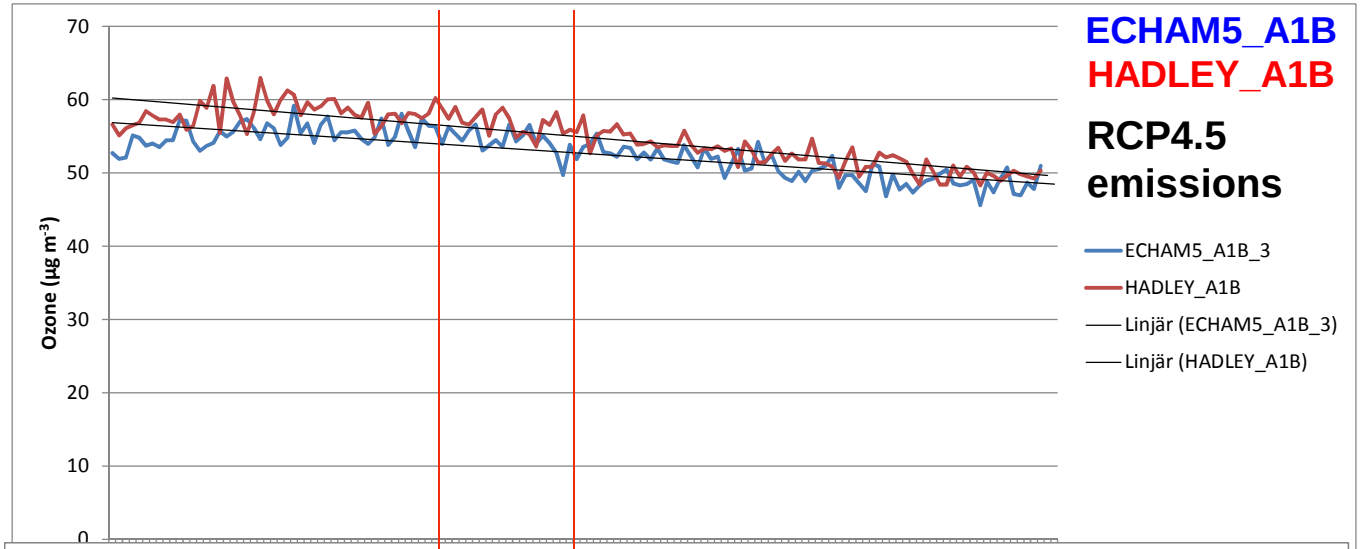


Precipitation:
~ 20 mm/year
more rain

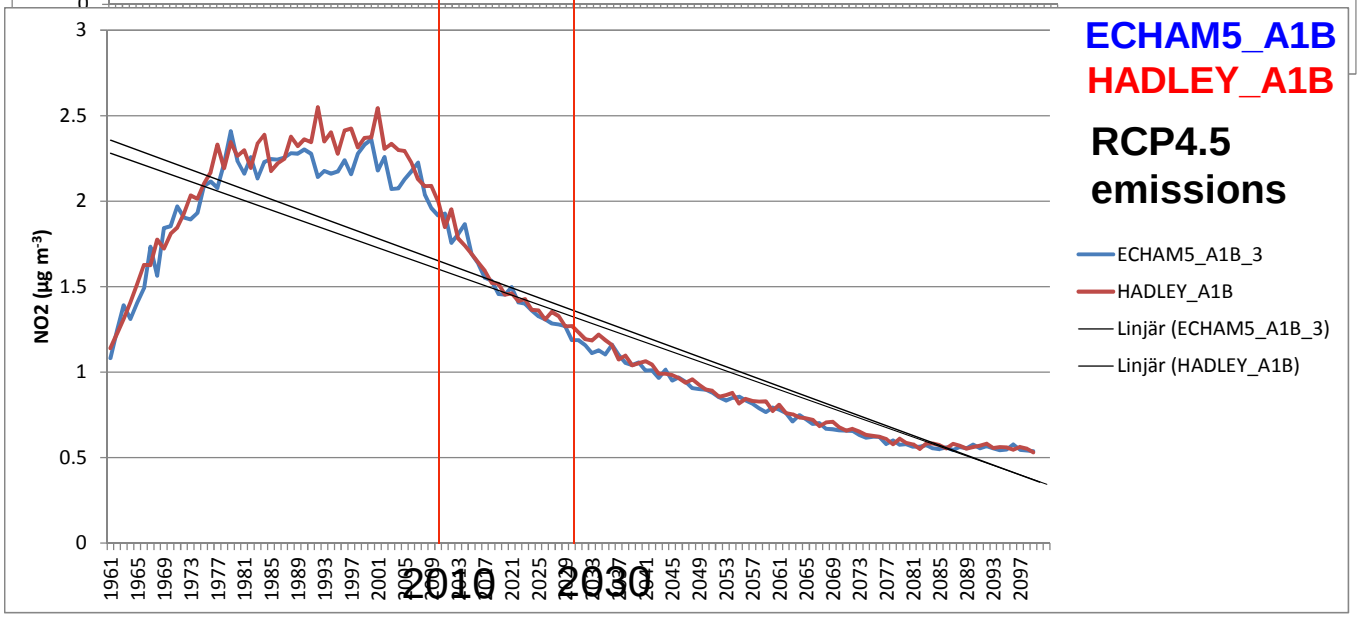


LRT ozone and NO2 coming in to Stockholm 1960-2100 (change 2010-2030)

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



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



2. Uncertainties in anthropogenic emissions

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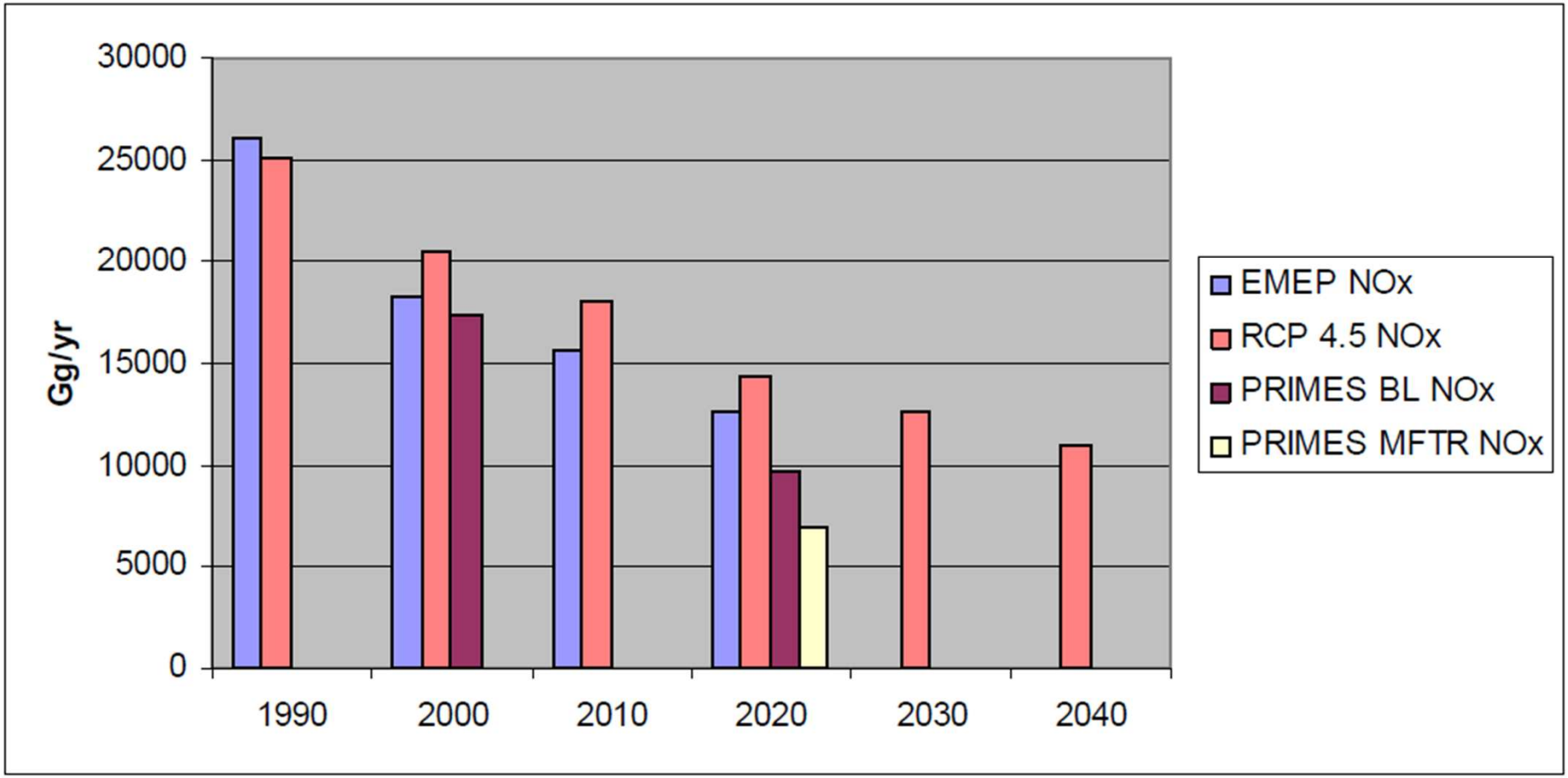

Downscaling model setup

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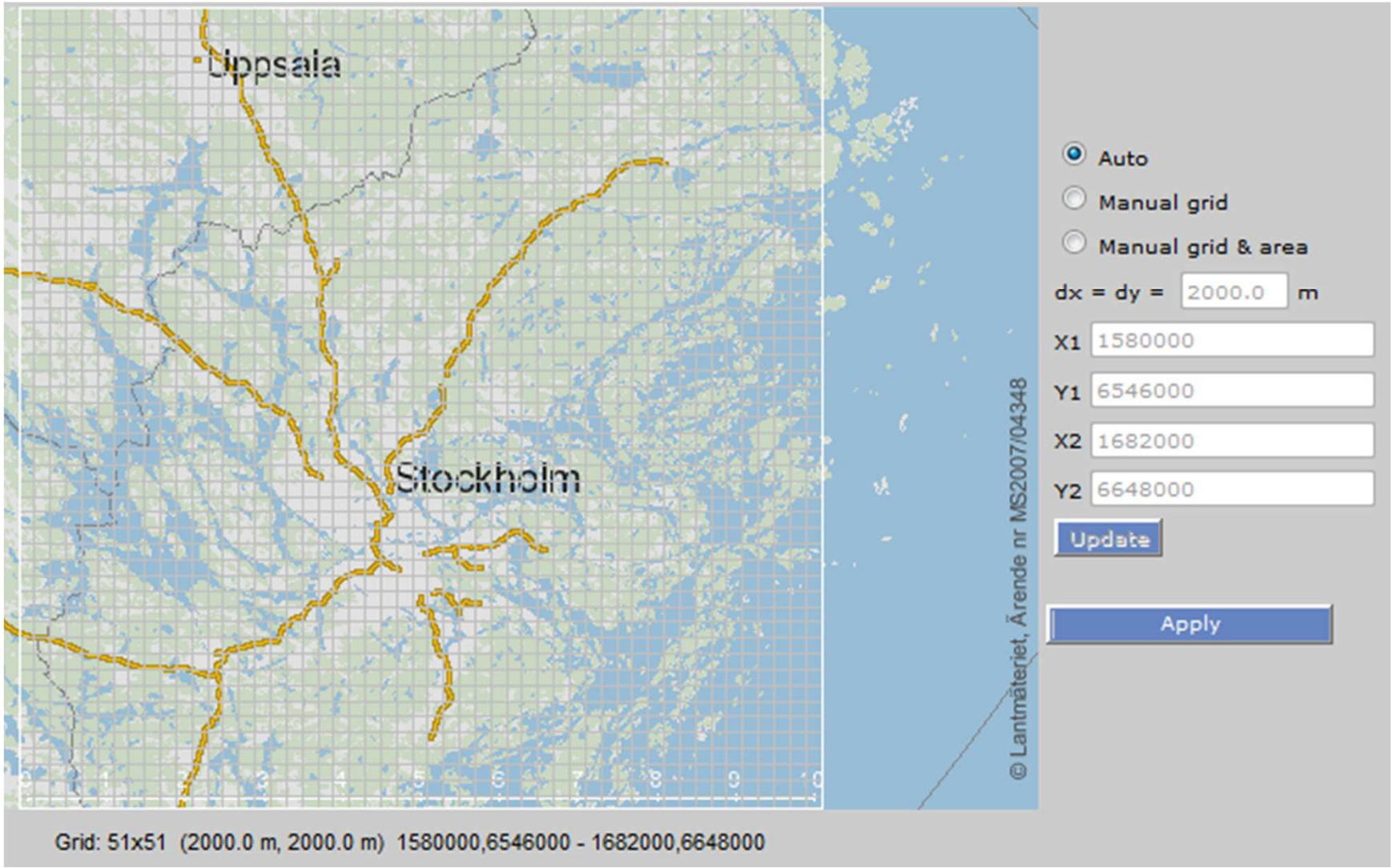

102 x 102 km^2

Example: Modelled NO_2 concentration over Stockholm

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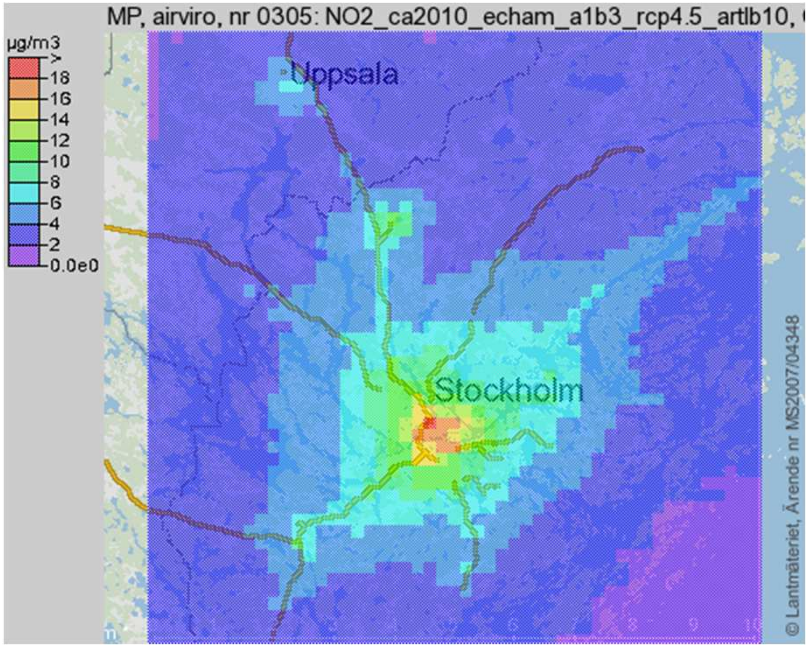
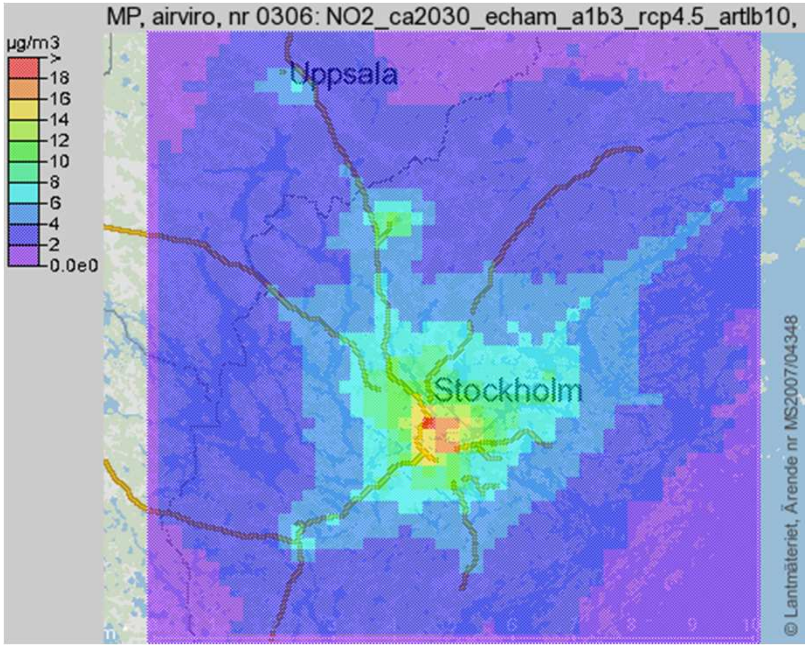
~2010



~2030



Note:

- Stockholms emissions kept constant at 2010 level
- ECHAM A1B for climate forcing
- RCP4.5 time varying emissions

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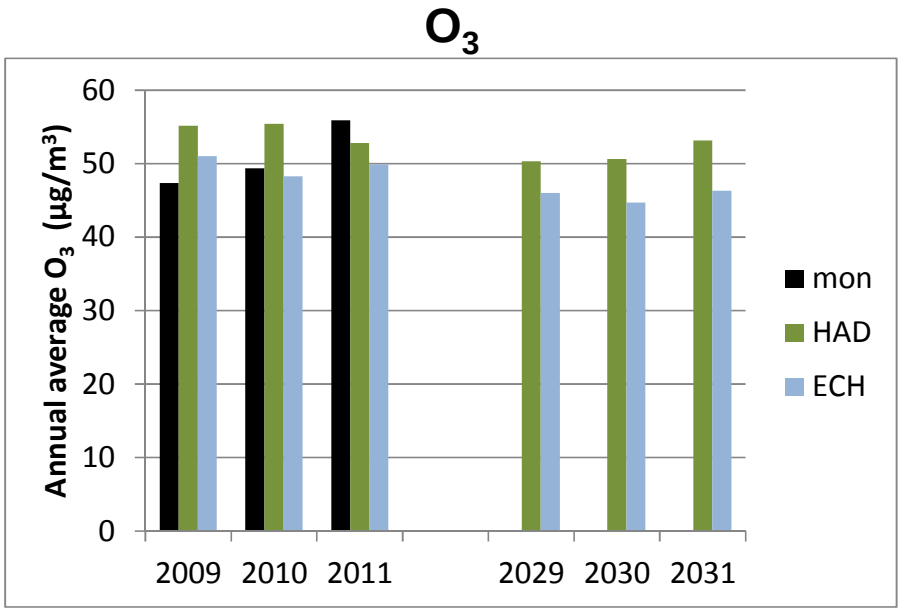
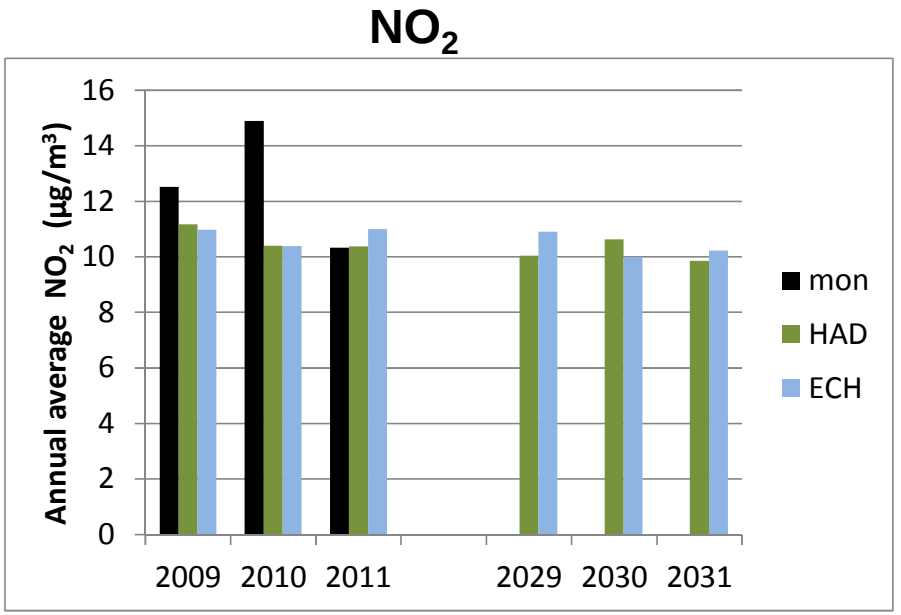
Model results evaluated at the urban background monitor station:





- Ozone levels in incoming air will be moderately reduced (5 µgm^{-3} or 10%) up to 2030

- NO2 is dominated by local contributions and measured values show a large year-to-year variability. No clear trend in incoming air concentrations.

Change in local emissions

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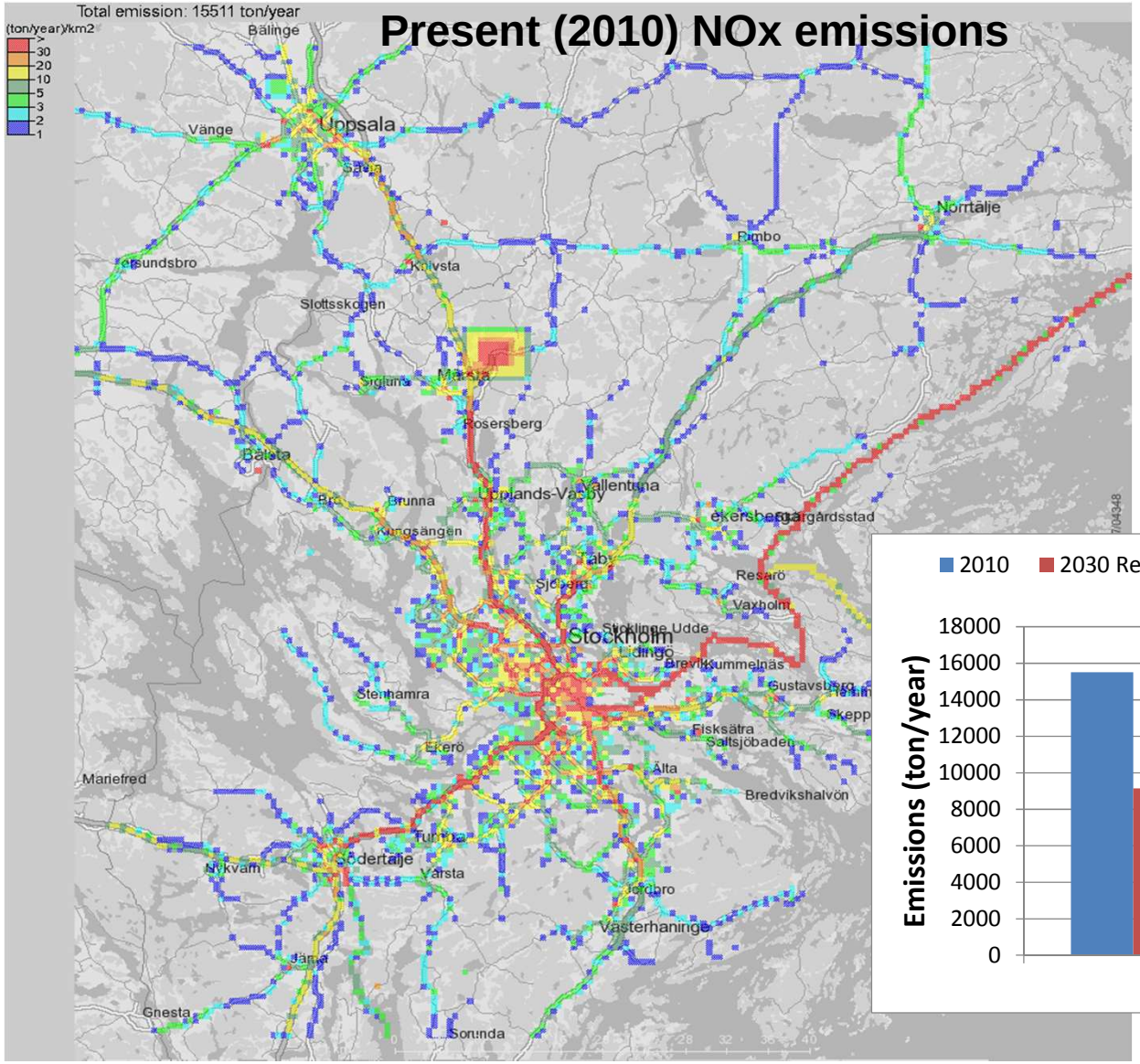
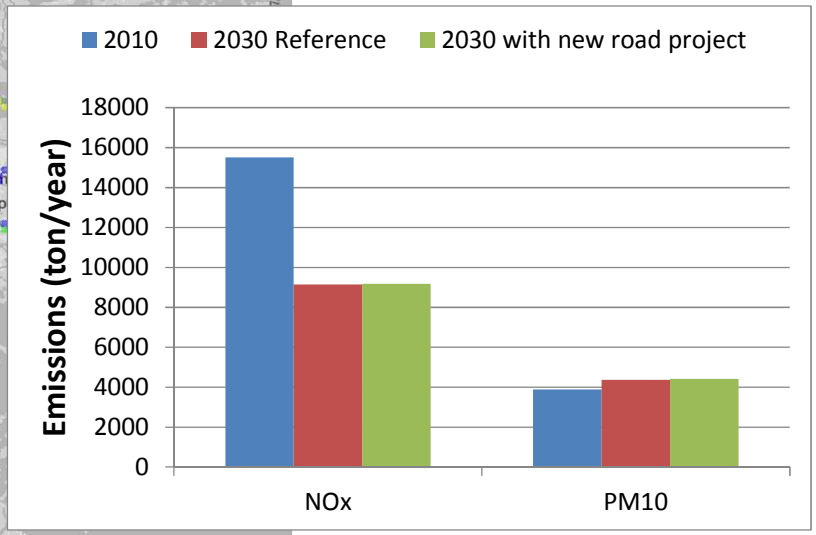


Two 2030 scenarios:

- Reference

- New road project



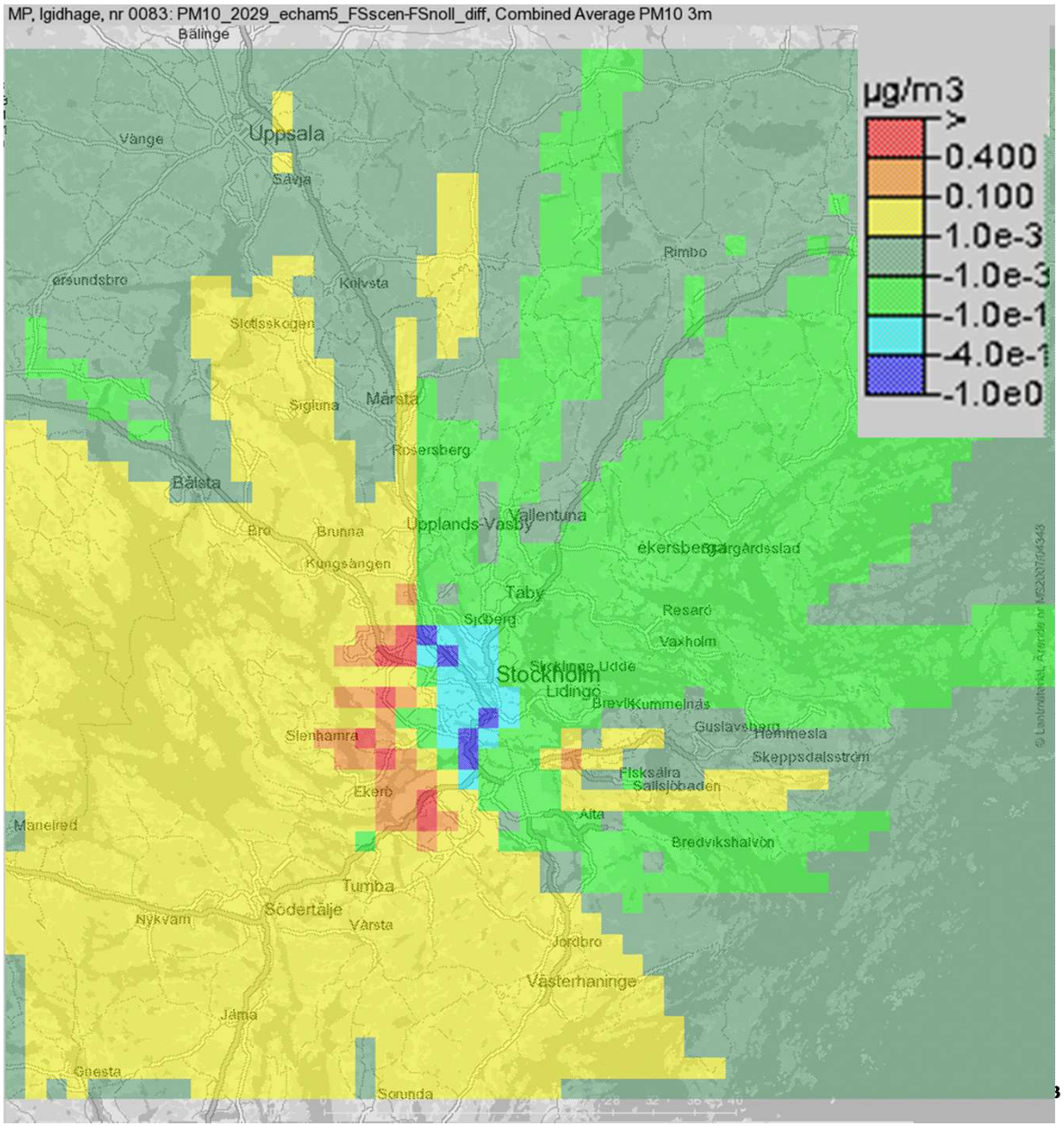
Results of local scenario simulations

Difference in PM10:

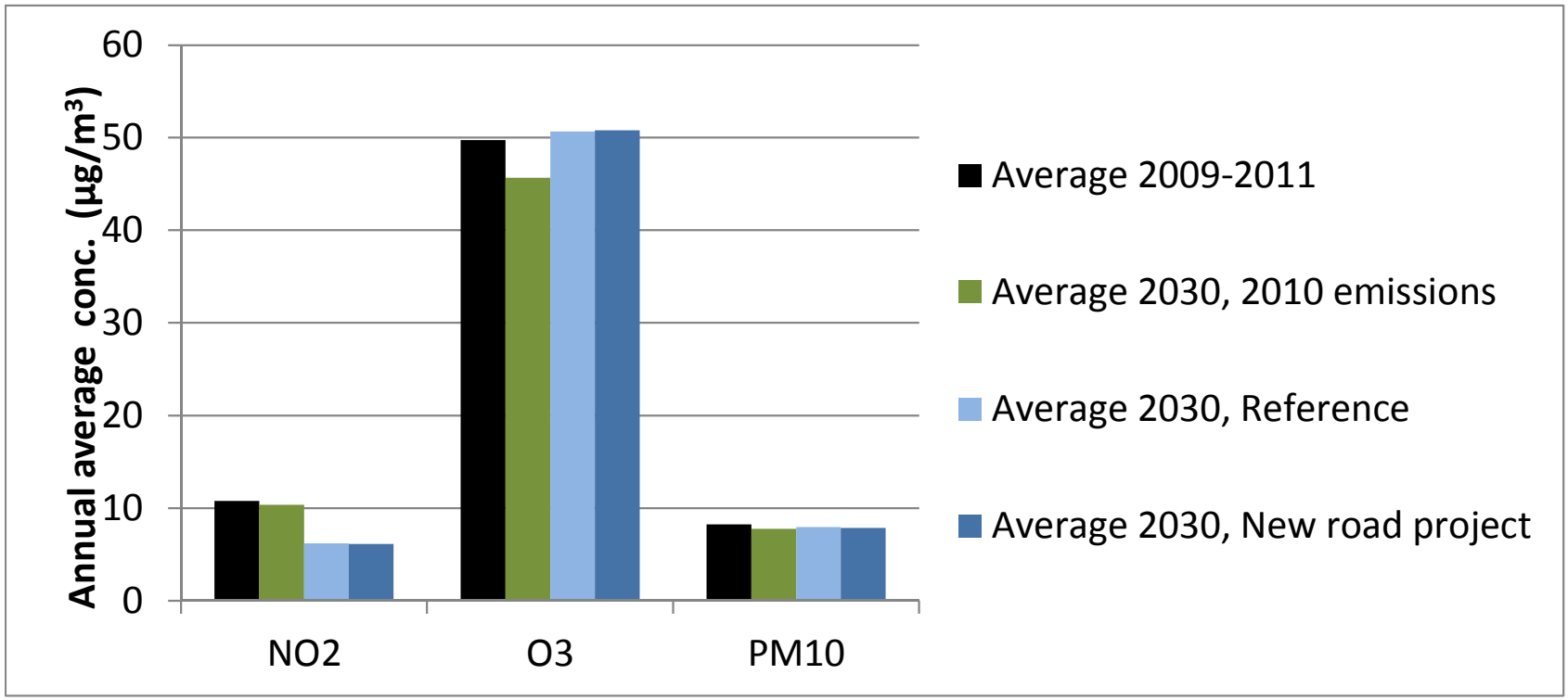
Scenario ”New project”

minus

Scenario ”Reference”



Model simulated concentrations at the urban background station in city centre (only ECHAM5 climate scenarios shown)



Conclusions

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- Climate change effects on long range pollutant concentrations arriving to Stockholm seems to be fairly small and are easily overrided by the effect of emission reductions in Europe.

- Local NO2 concentrations are likely to go down in the future, much due to EU legislation on vehicle emissions that leads to lower emissions both in Europe and locally in Stockholm.

- Ozone in incoming air will likely go down. Due to less NO emissions in Stockholm, the urban background ozone will rise. In total this leads to similar ozone levels in 2030 as today.

- The effect of the large road transit project is small on overall emissions and averaged concentrations. The change in spatial distribution can however have more effect on population exposure (to be studied).

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http://www.suplan.eu/

Partners

1. Swedish Meteorological and Hydrological Institute
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7. Stockholm Uppsala Air Quality Management Association
8. City of Wuppertal
9. Technische Universität Graz