WP5. Atmospheric forcing (air-sea interaction processes**, deposition, transient runs including control and scenarios)**

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Atmospheric deposition of nutrients and acidic substances 1960 to 2006 (Björn Carlsson)

- Deposition data 1990/1995 to 2006 from EMEP model.
- Reconstruct earlier data from:
  - Emission data EDGAR-HYDE1.3 1960 to 1990 (every 10:th year)
  - Emission data EDGAR 3 1990 to 2000 also including airplane and boat emissions (to determine emission region).
- Method
  - annual cycle from EMEP
  - long term trend from EDGAR-HYDE (1960-1990)

Atmospheric deposition of nutrients and acidic substances 1960 to 2006 (Björn Carlsson)

- Deposition to the Baltic Sea: oxidised sulphur and nitrogen, reduced nitrogen
- In addition, deposition of nutrients to land surfaces (interpolated measurements from EMEP): Na, Mg, Cl, K, Ca

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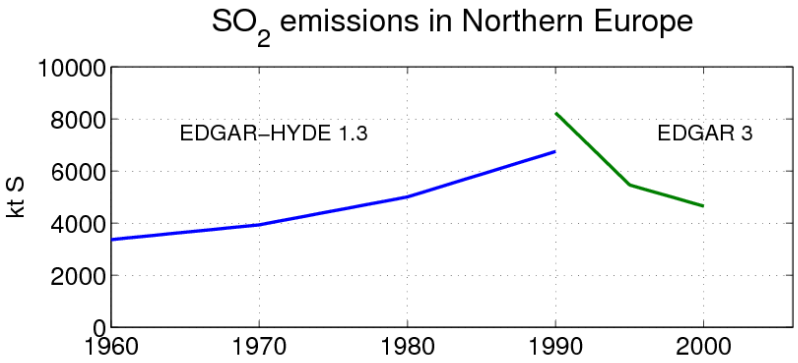
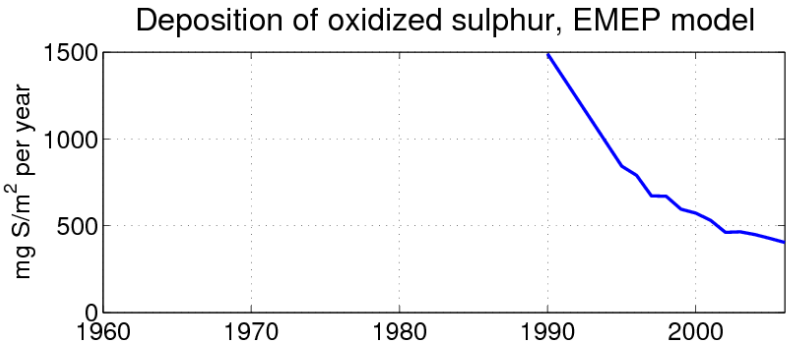
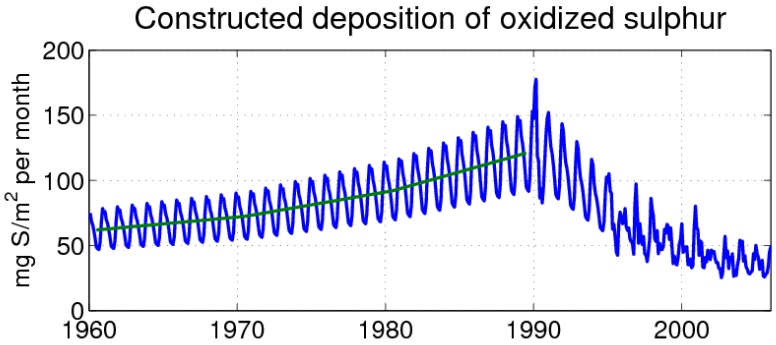
SO_2 (Björn Carlsson)







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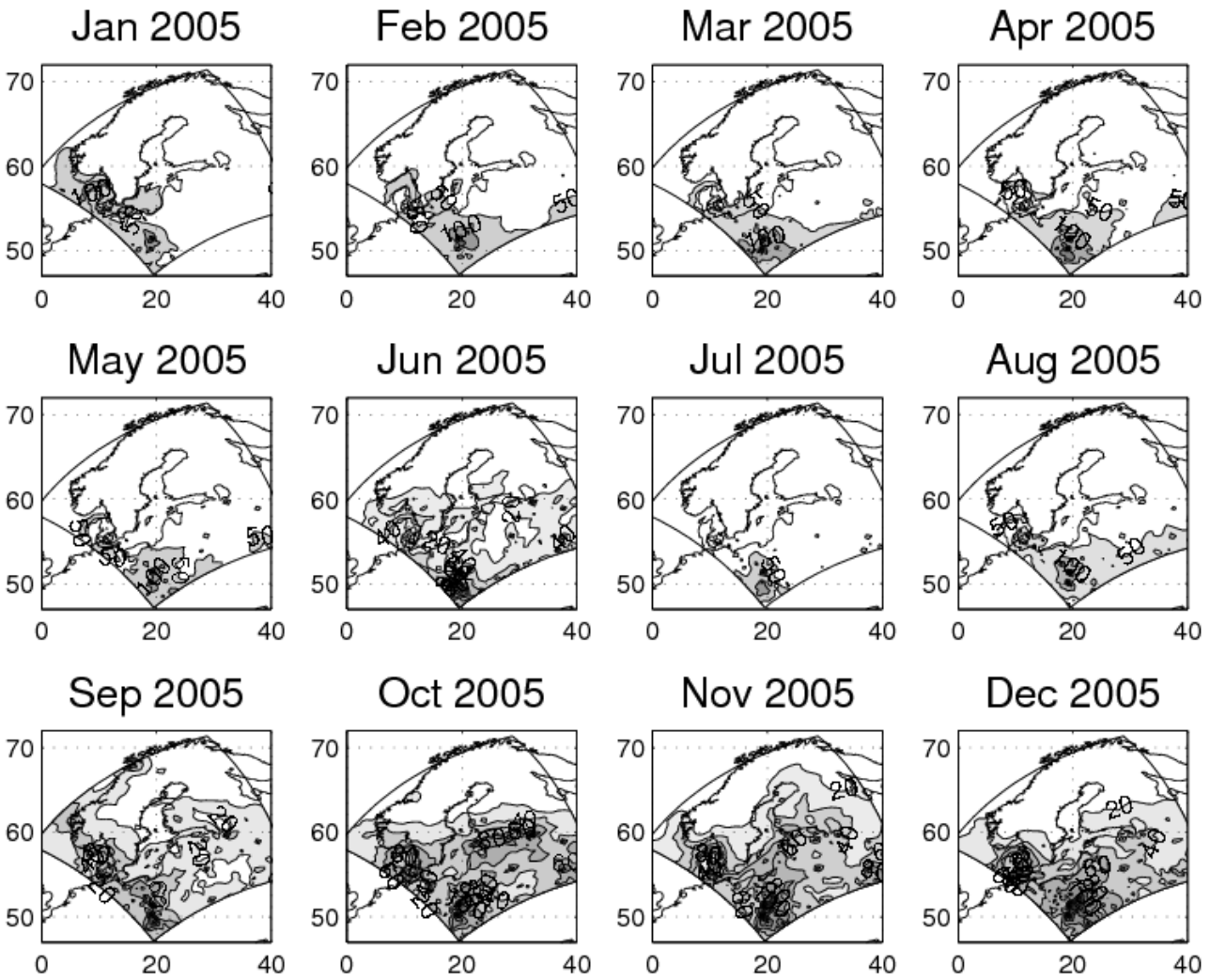

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Transient runs including control and scenarios, 1960-2100 from the Rossby Centre, SMHI and projects PRUDENCE and EMSEMBLES

Choice of climate scenarios motivated by:

- Need dynamically regionally downscaled scenarios.
- Transient scenarios.
- A variety of scenarios/models to investigate the uncertainty of our modelling system to uncertainties in forcing data (robustness of results).
- Availability of scenarios

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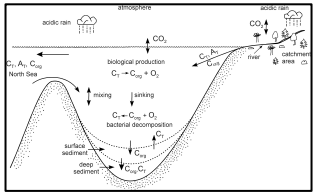
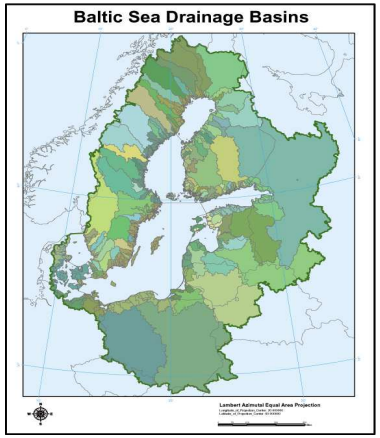
Transient runs including control and scenarios, 1960-2100 from the Rossby Centre, SMHI and projects PRUDENCE and EMSEMBLES

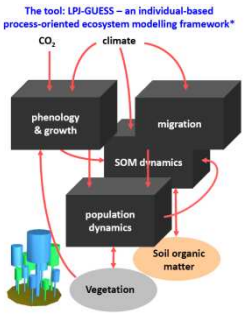
Baltic Sea model

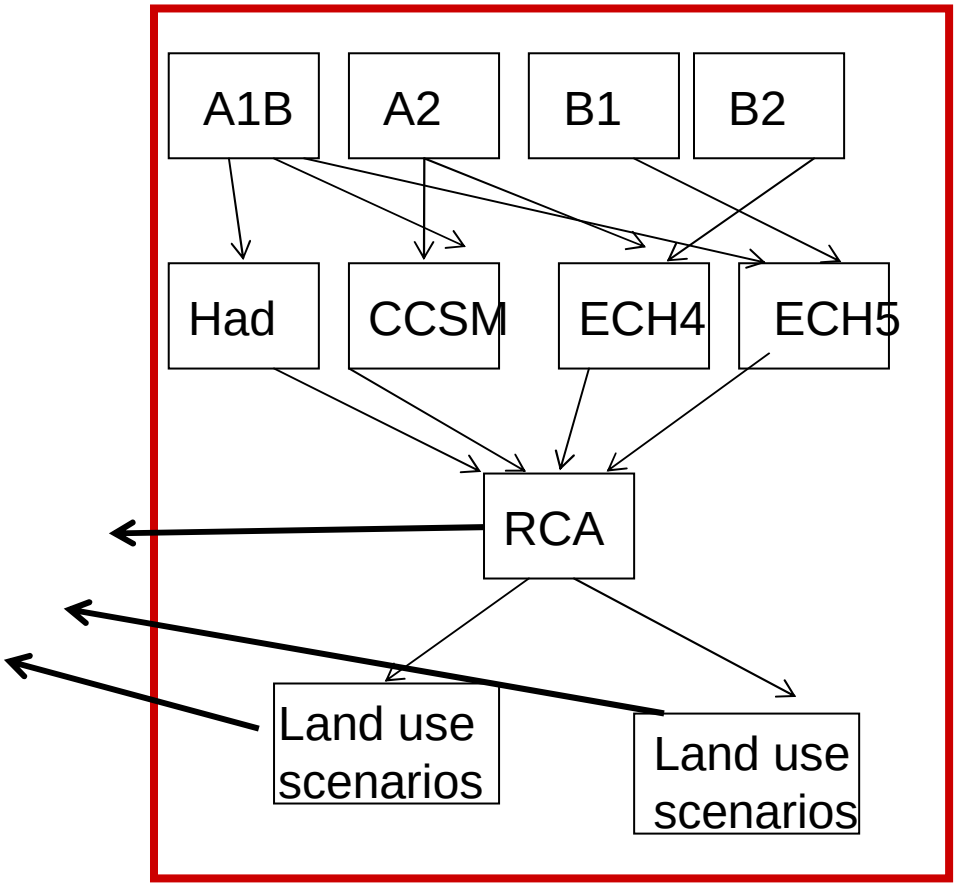


Runoff model



Ecosystem model





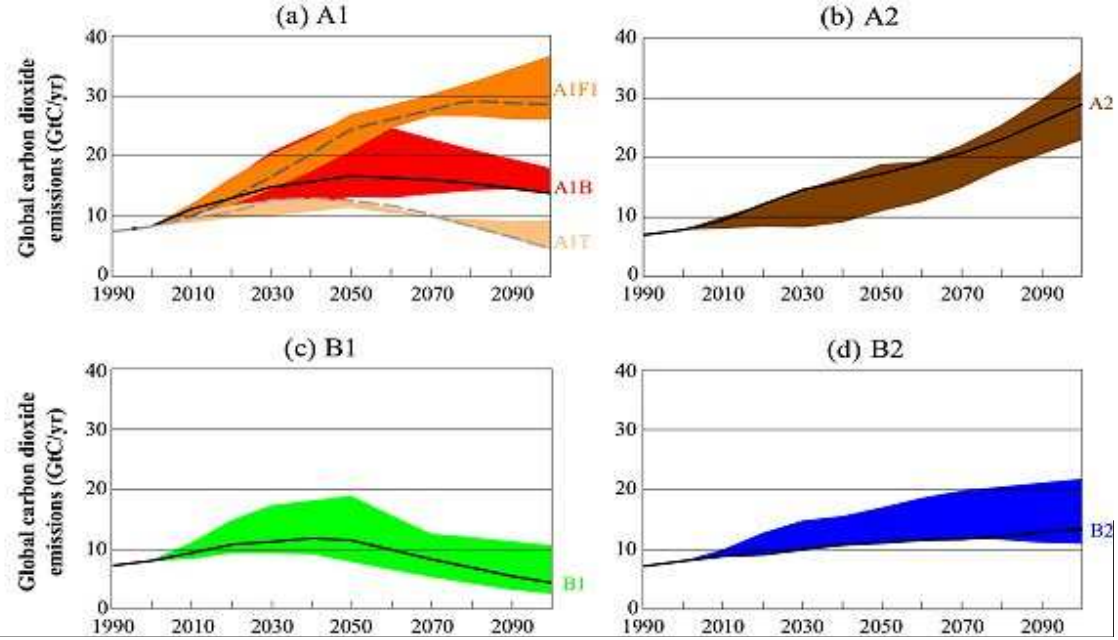
• Two (three) different scenarios: A1B, A2, B2 to investigate the sensitivity of the BS climate system to the anthropogenic forcing

Storyline A1: Rapid economic growth, population peaks in mid-century, new technologies, reduction in regional differences. A1B-balance across energy sources.

Storyline A2: Heteorogeneous world, continously increasing populations, economic development is regionally oriented.

Storyline B2: Emphasis on local solutions and environmental sustainability. Continously growing population (at lower rate than A2)

Emission scenarios



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Global coupled atmosphere-ocean general circulation models (AOGCMs)

Emission scenarios are used in global climate models (GCM:s) during extended periods, we will use three different GCM:s.

• We will focus on the ECHAM4 model, and ECHAM5, which is an improved version of ECHAM5, developed at Max-Planck-Institute for meteorology.

ECHAM5 – improved cloud parameterisation and land surface scheme, improved semi-lagrangian transport scheme

• The Community Climate System Model (CCSM) is a coupled climate model for simulating the earth's climate system developed at NCAR.

• HadCM3, is the Hadley Centre HadAM3H atmosphere model plus ocean GCM.

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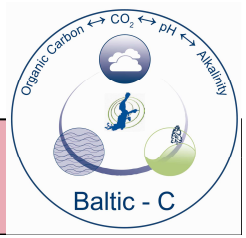
Regional climate model (RCM)

The GCM:s gives coarse information and for a smaller area like the Baltic Sea the simulation needs to be downscaled, we use dynamical downscaling with a RCM.

We will use one RCM and when looking at monthly mean values/seasonal variations the different RCM:s are relatively similar. RCM:s differ more in parameters with a larger variability (extreme precipitation, daily cycle etc).

We use the RCA3 RCM model, which is the Rossby Centre regional climate model (Kjellström et al, 2005), with/without the ocean component for the Baltic Sea (RCA/RCAO). Available from Ensembles/Prudence EU-projects.

Temperature errors within ±1degree (positive bias NE, negative bias in Mediterranean). Precipitation overestimated. There seems to be a problem with RCA3 10 m winds (too low), gustiness can be added.



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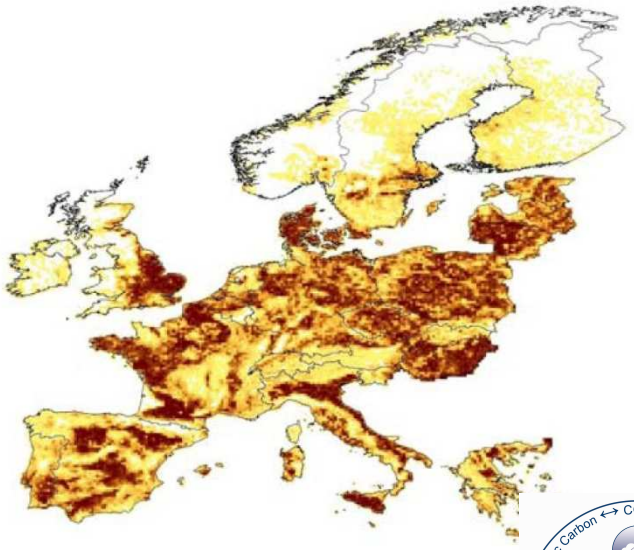
Land use scenarios

- From EU FP6 project ALARM
- Consistent with storylines in emission scenarios
- Input to ecosystem model



Reginster, I., Rounsevell, M., Butler, A. and Dendoncker, N. (2009) Land Use Change Scenarios for Europe. In Atlas of Biodiversity Risk, Eds. Settele J, Penev L, Georgiev T, Grabaum R, Grobelnik V, Hammen V, Klotz S, Kühn I Pensoft Publishers, Sofia-Moscow.
ISBN 978-954-642-446-4 (print) and ISBN 978-954-642-447-1 (e-book)

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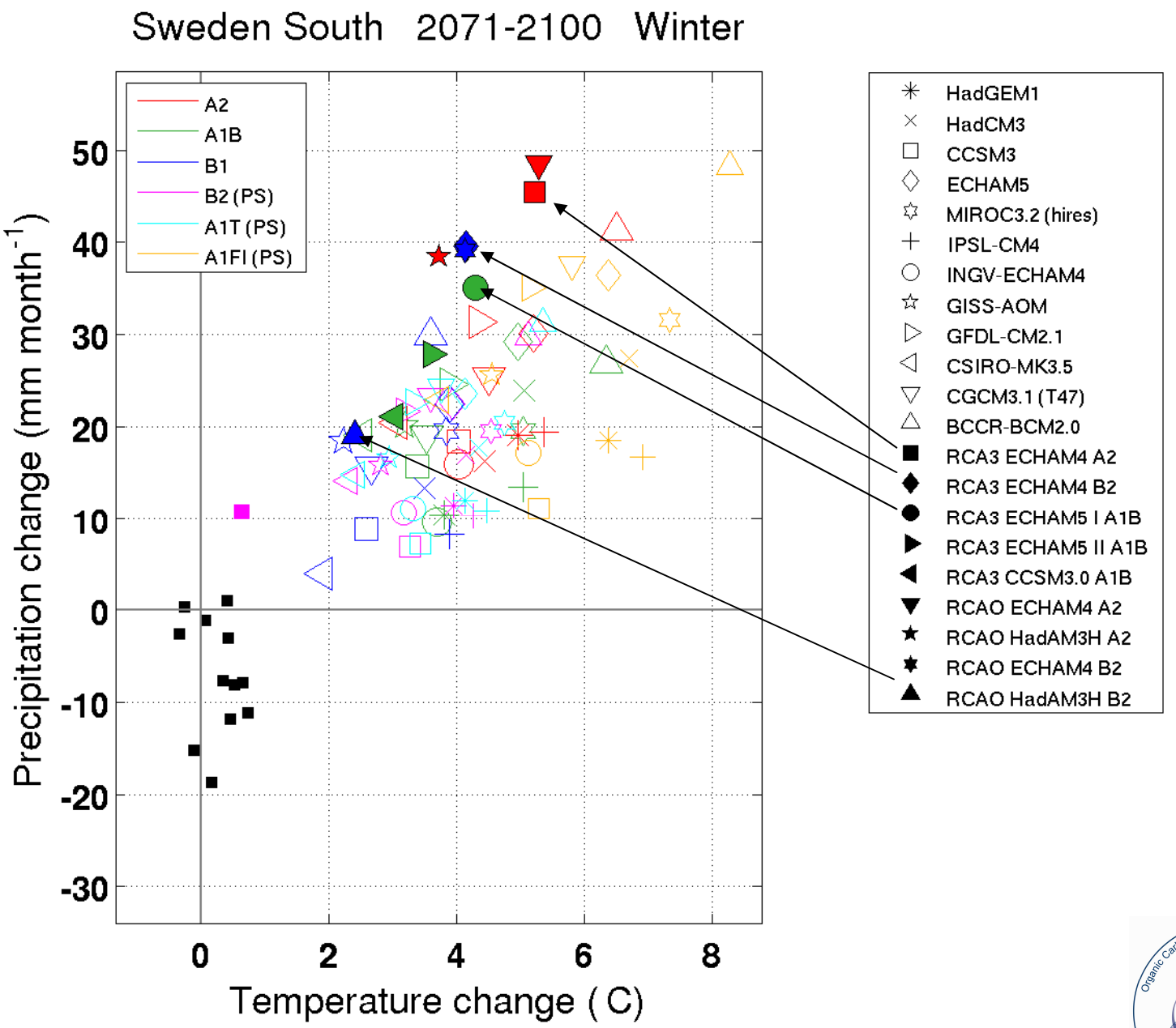

From Erik Kjellström

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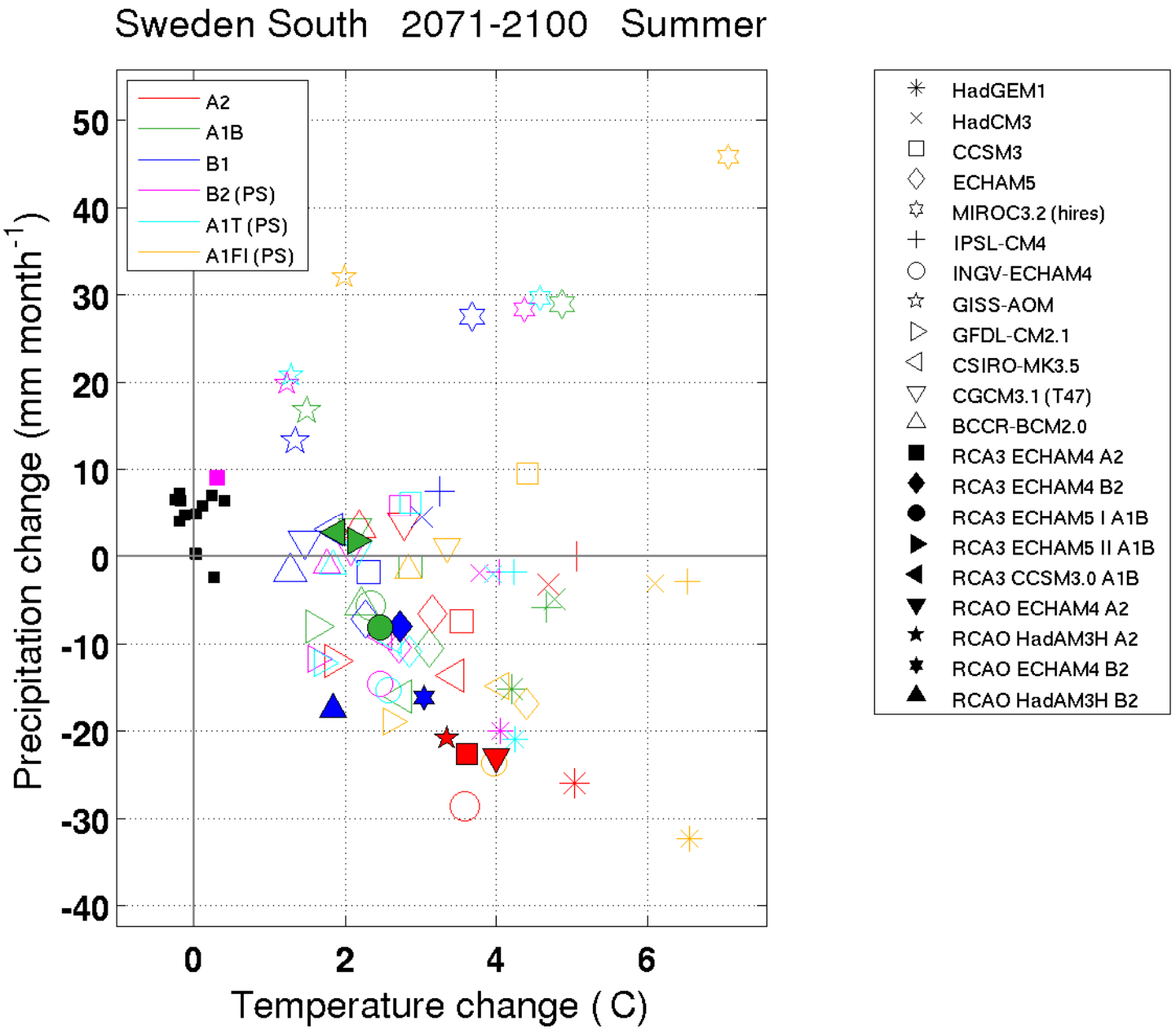

From Erik Kjellström

Global coupled atmosphere-ocean general circulatio models (AOGCMs), figure from Erik Kjellström

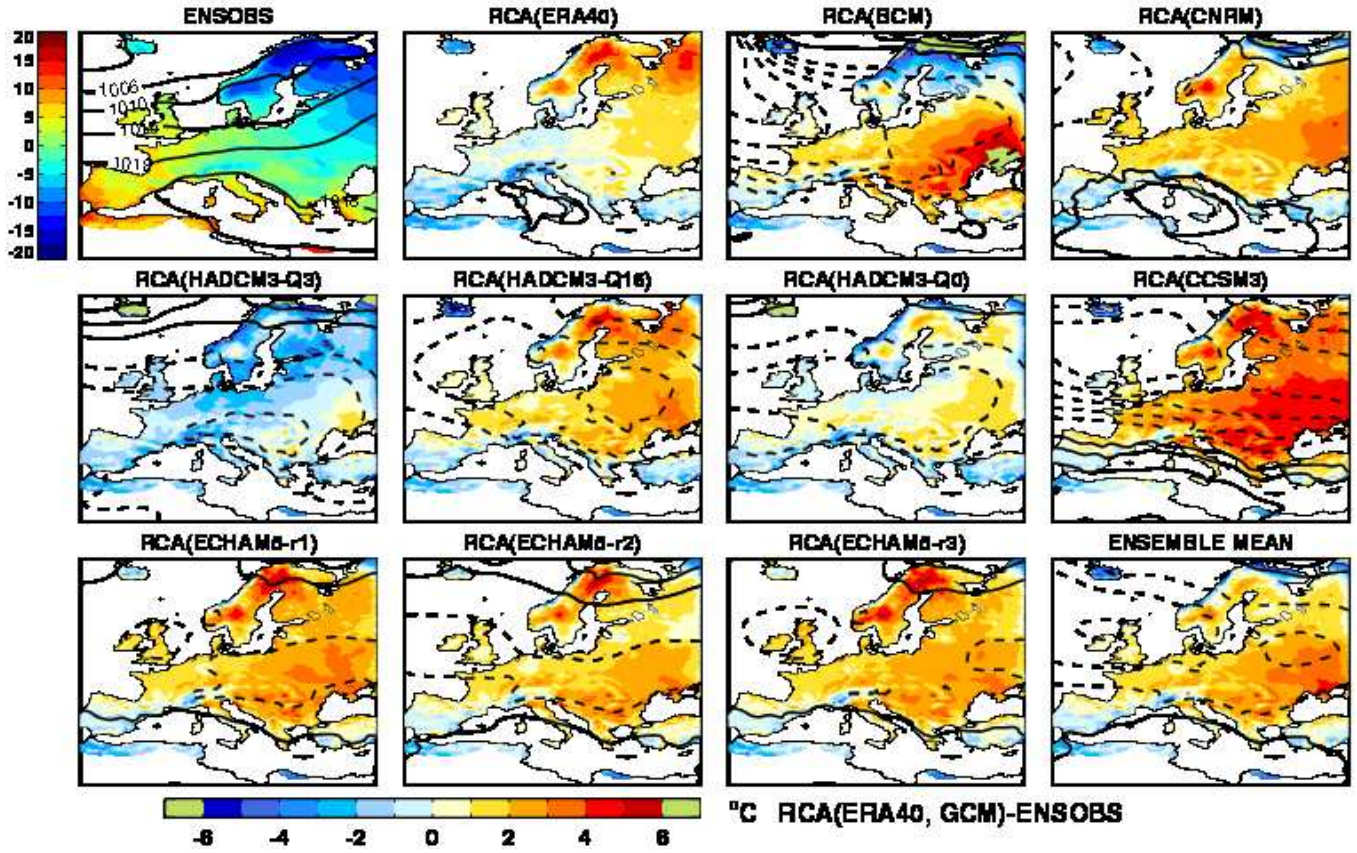

Figure 1. 2m-temperature and mean sea level pressure (contours) in winter (DJF) in the 1961-1990 period. The uppermost left panel shows the ENSEMBLES gridded observational 2m-temperatures (Haylock et al. 2008) and the ERA40 MSLP (Uppala et al. 2005). The one labeled RCA3(ERA40) shows biases compared to the uppermost left panel in an ERA40 downscaling simulation with RCA3. The other panels show biases from the individual 50km A1B-simulations listed in Table 1. The mean (lower right) is taken over the ensemble consisting of 5 simulations with different AOGCMs in the two rightmost columns. MSLP biases are shown for every 2 hPa except 0 (dashed for negative numbers).

Global coupled atmosphere-ocean general circulatio models (AOGCMs), figure from Erik Kjellström

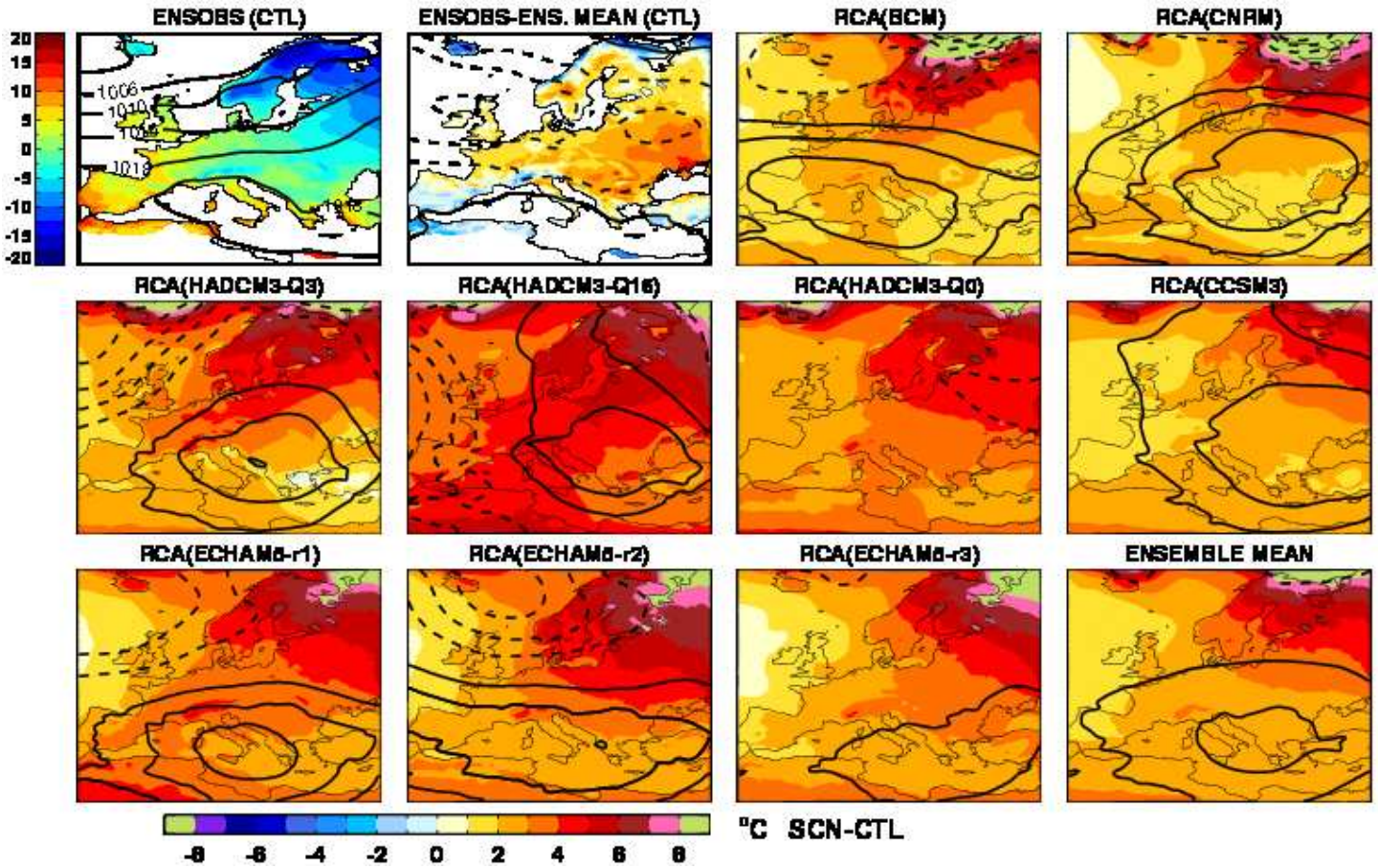

Figure 2. Change in 2m-temperature and mean sea level pressure (contours) between 2071-2100 compared to 1961-1990. The uppermost two panels to the left shows the ENSEMBLES project gridded observational 2m-temperatures (Haylock et al. 2008) and the ENSEMBLE mean bias from Figure 1. The other panels are results from the individual A1B-simulationsat 50km horixontal resolution listed in Table 1 The mean (lower right) is taken over the ensemble consisting of 5 simulations with different AOGCMs in the two rightmost columns. MSLP changes are shown for every 2 hPa (CTL) and every 1 hPa (SCN-CTL) except 0 (dashed for negative numbers).

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Climate scenarios, atmospheric forcing:

Over sea every 3H:
Grid averaged temperature and relative humidity (2m)
Total cloudiness
Precipitation
Geostrophic wind
Sea level pressure at Debilt and Oksoya

Land ecosystem modelling 24H averages:
shortwave radiation
CO2
2m temperature
Precipitation

Land catchment modelling 24H averages:
Grid averaged 2m temperature
Precipitation

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