First results of recently performed scenario simulations for the Baltic Sea for 1961-2099

H.E. Markus Meier

Swedish Meteorological and Hydrological Institute and Stockholm University

ECOSUPPORT co-workers

Annual General Assembly 15 Oct 2009

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BONUS INFLOW

ECO SUPPORT

First results of recently performed scenario simulations for the Baltic Sea for 1961-2099

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AMBER

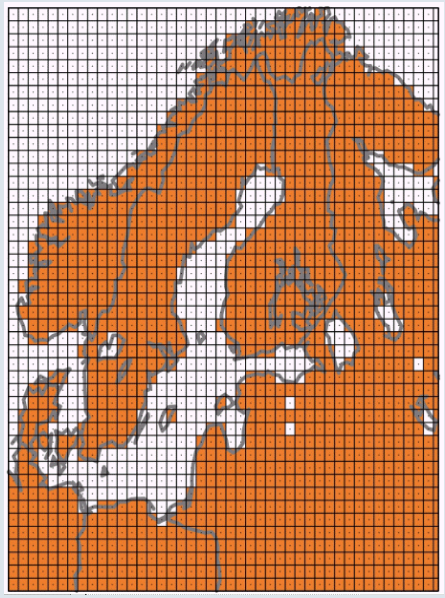
BONUS INFLOW

ECO SUPPORT

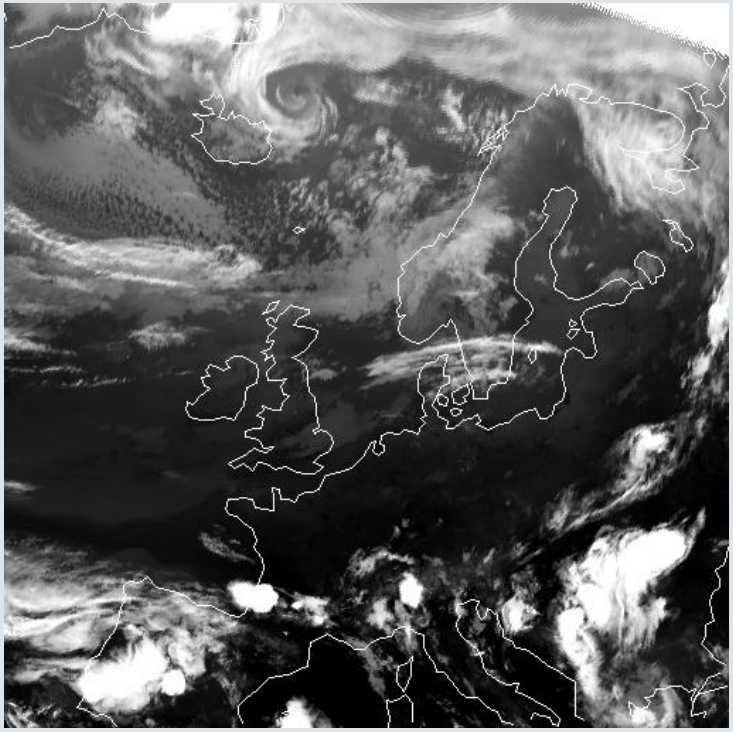
Regional climate models:
Improving global climate scenarios

- Increased resolution → detailed regional forcing
- Greater number of explicitly resolved processes

Global



Regional



SMHI

New simulations at SMHI:

1. Hindcast simulation 1961-2007:
   RCAO/ERA-40
2. Two transient simulations 1961-2099:
   RCAO/GCM

New compared to BACC: no time slices,
IPCC 2007, new model versions

The Rossby Centre ensemble

No	AOGCM (Institute, country)		Emission scenario	Horisontal resolution (km)
1	Arpège (CNRM, France)		A1B	50
2	BCM (NERSC, Norway)		A1B	50
3				25
4	CCSM3 (NCAR, USA)		A2	50
5			A1B	50
6			B2	50
7	ECHAM4 (MPI-met, Germany)		A2	50
8			B2	50
9	ECHAM5 (MPI-met, Germany)		*A2*	50
10			A1B	50
11				50
12				50
13				25
14				*12.5*
15			B1	50
16	HadCM3 (Hadley Centre, UK)	ref (Q0)	A1B	50
17		low (Q3)		50
18		high (Q16)		50
19		low (Q3)		25
20	*IPSL-CM4 (IPSL, France)*		*A1B*	*50*

All simulations on the ENSEMBLES grid with RCA3

The Rossby Centre ensemble

Different AOGCMs

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Different initial conditions

Different model formulation (GCM)

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The Rossby Centre ensemble

Different AOGCMs

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Different model formulation (GCM)

Different emission scenarios

Different horizontal resolution

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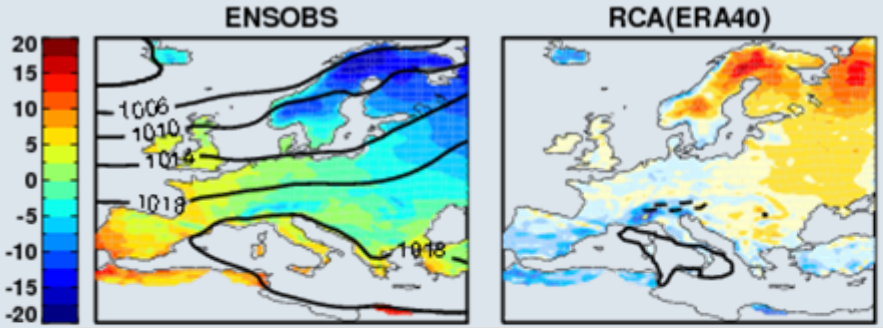
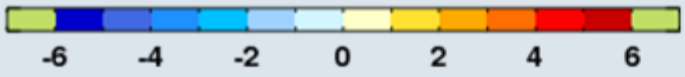
Biases in the recent past climate (1961-1990): winter (DJF) mean temperature and MSLP

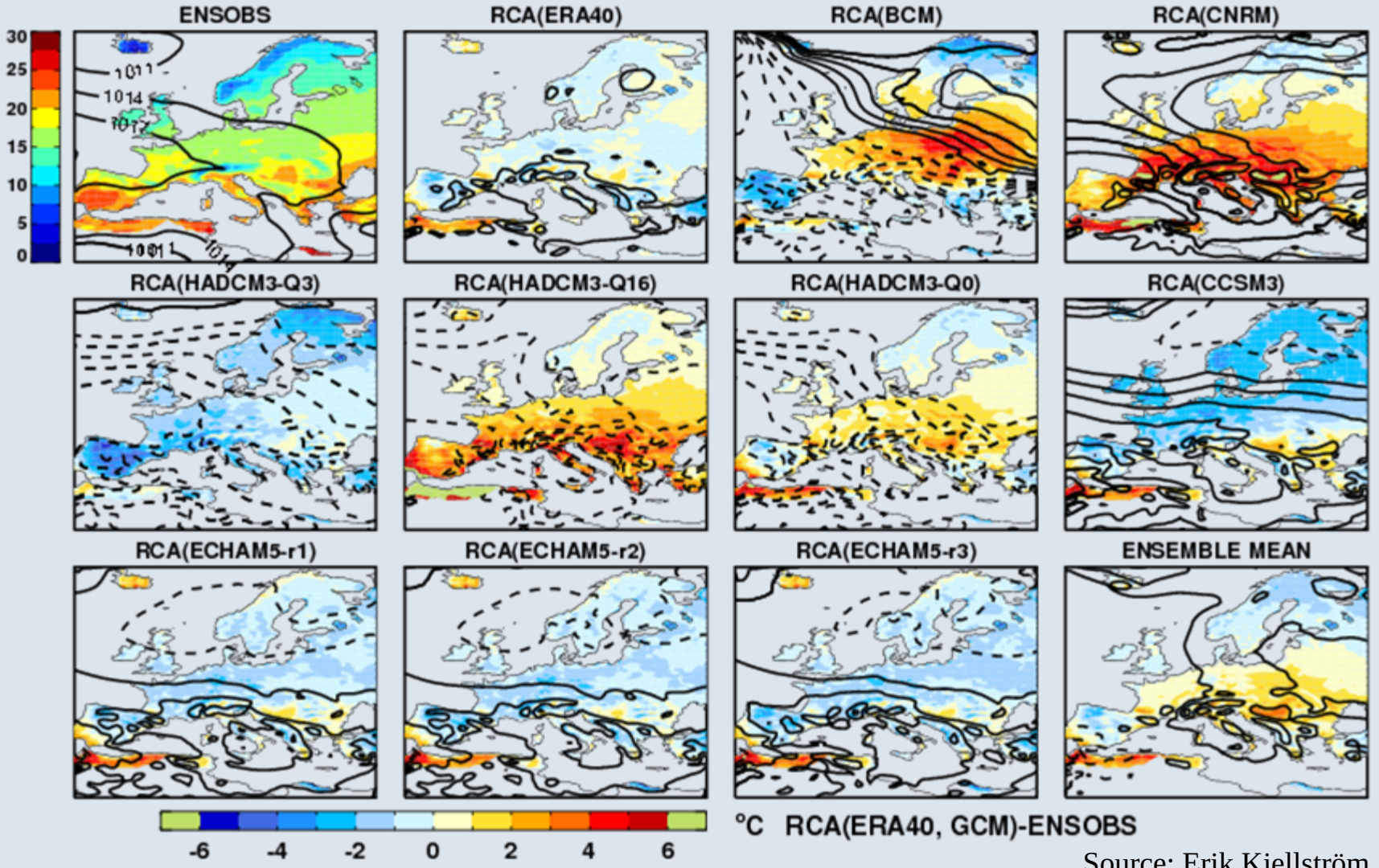




°C RCA(ERA40, GCM)-ENSOBS

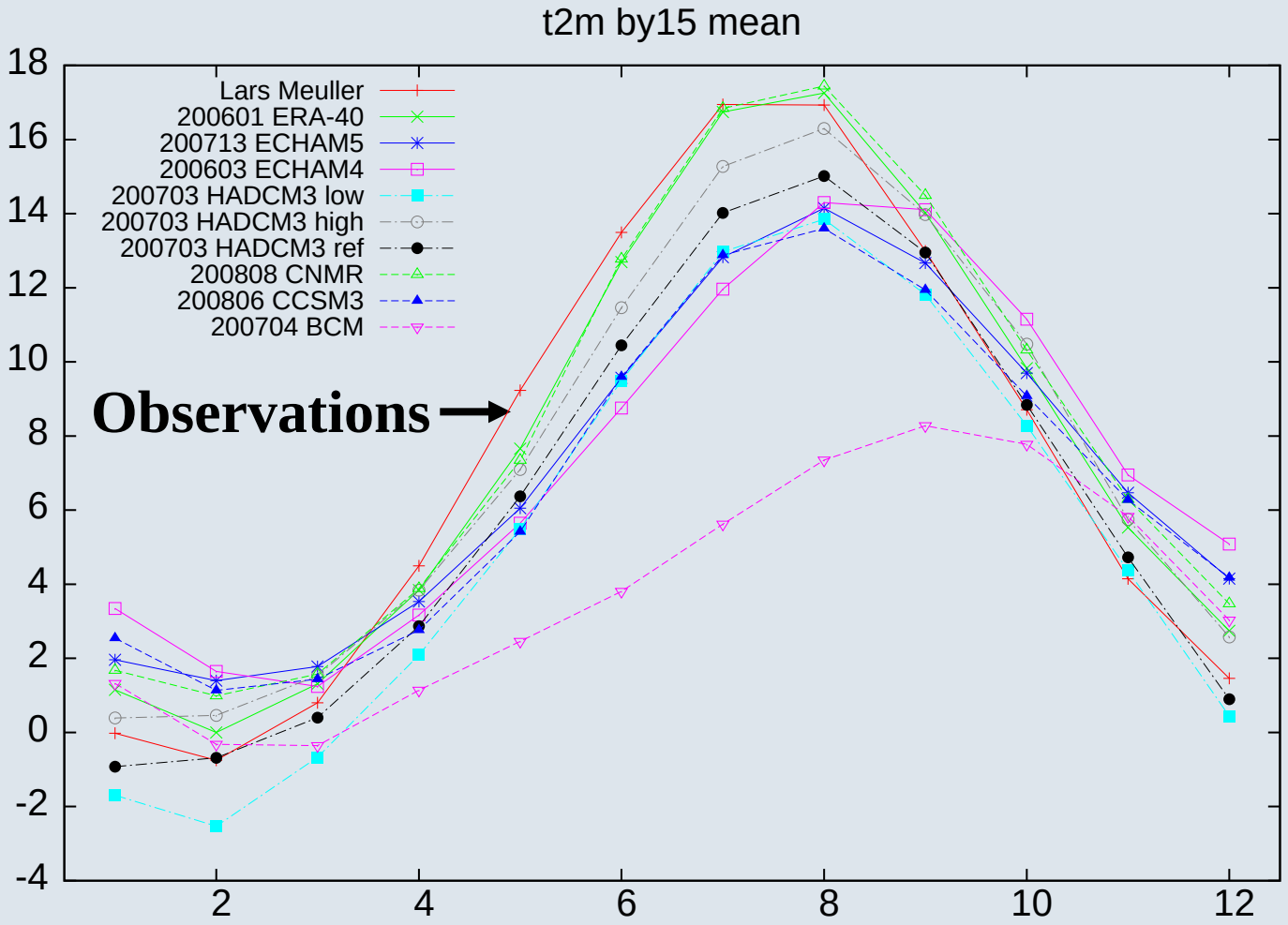
Source: Erik Kjellström, SMHI

Biases in the recent past climate (1961-1990): summer (JJA) mean temperature and MSLP

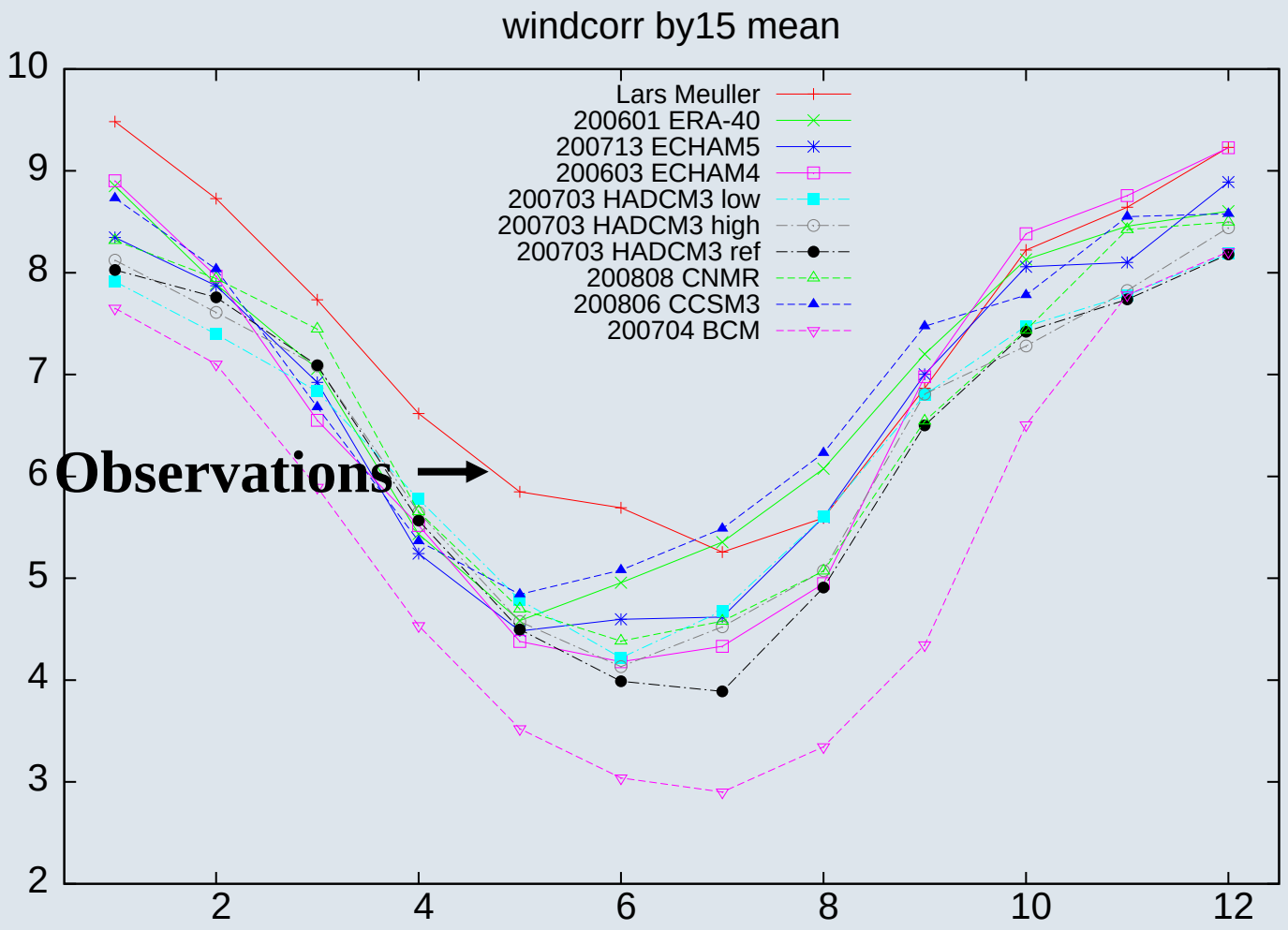


Source: Erik Kjellström, SMHI

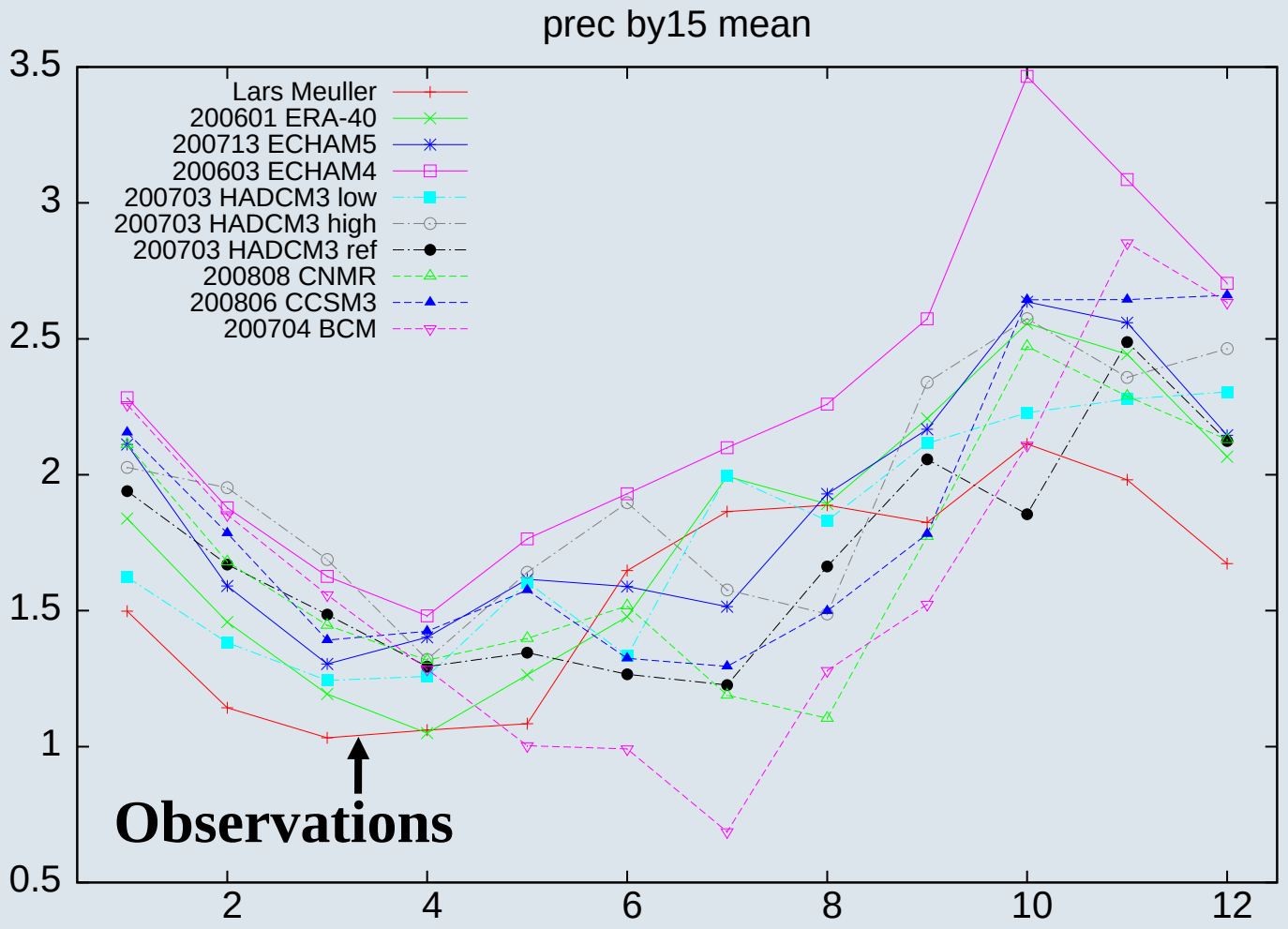
Seasonal mean 2m air temperature at Gotland Deep 1980-2006 – downscaling results using RCA



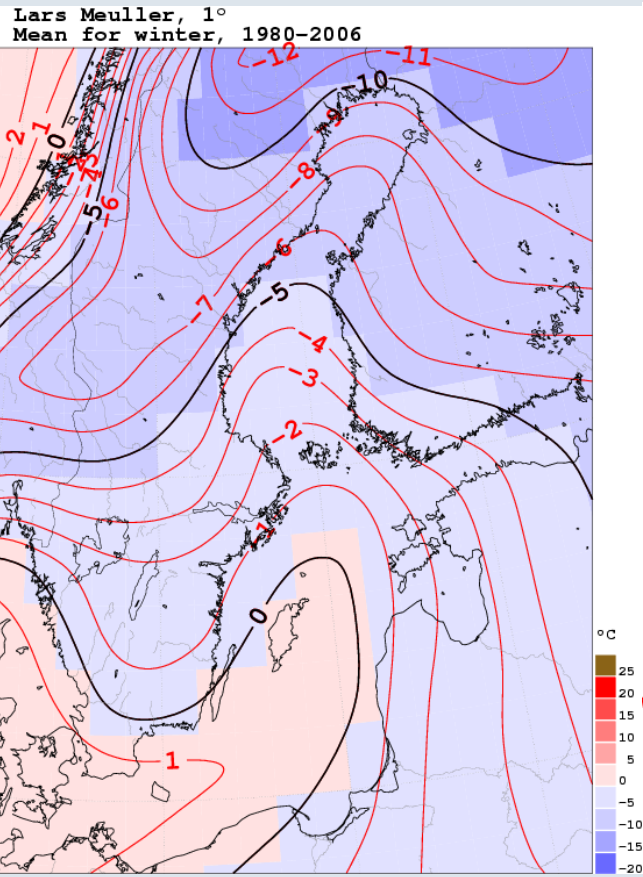
Seasonal mean 10m wind speed at Gotland Deep 1980-2006 – downscaling results using RCA

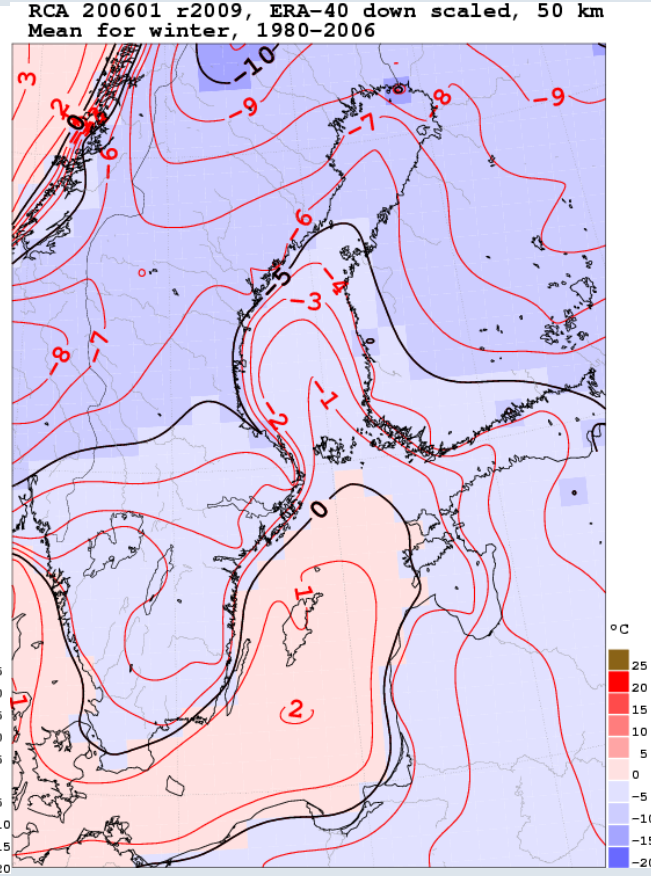


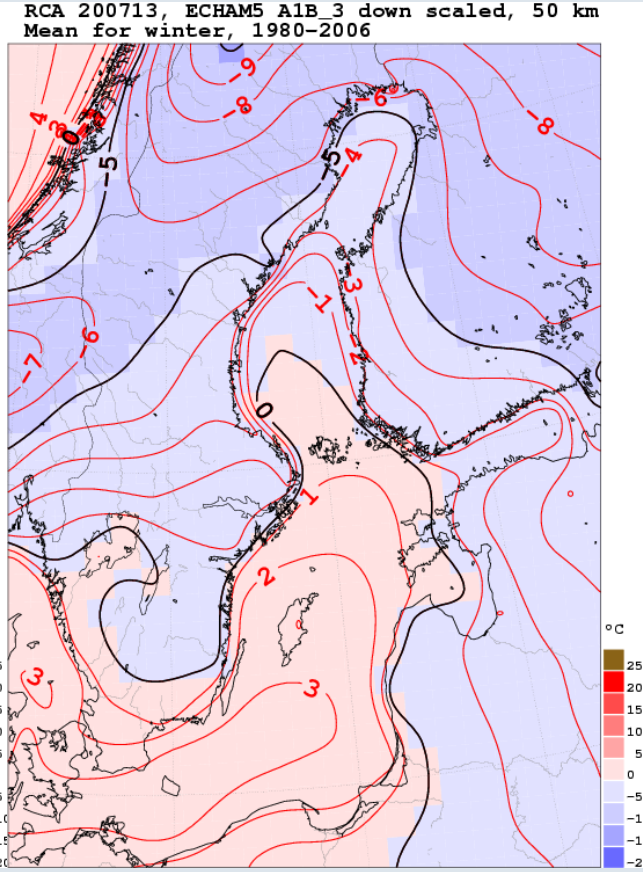
Seasonal mean precipitation at Gotland Deep 1980-2006 – downscaling results using RCA



Mean 2m air temperature (winter), 1980-2006

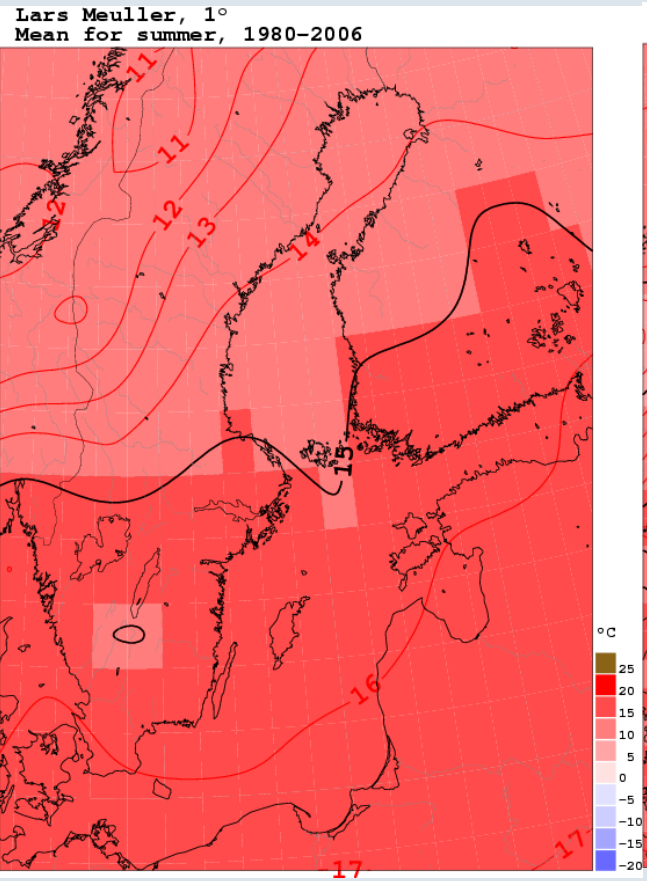




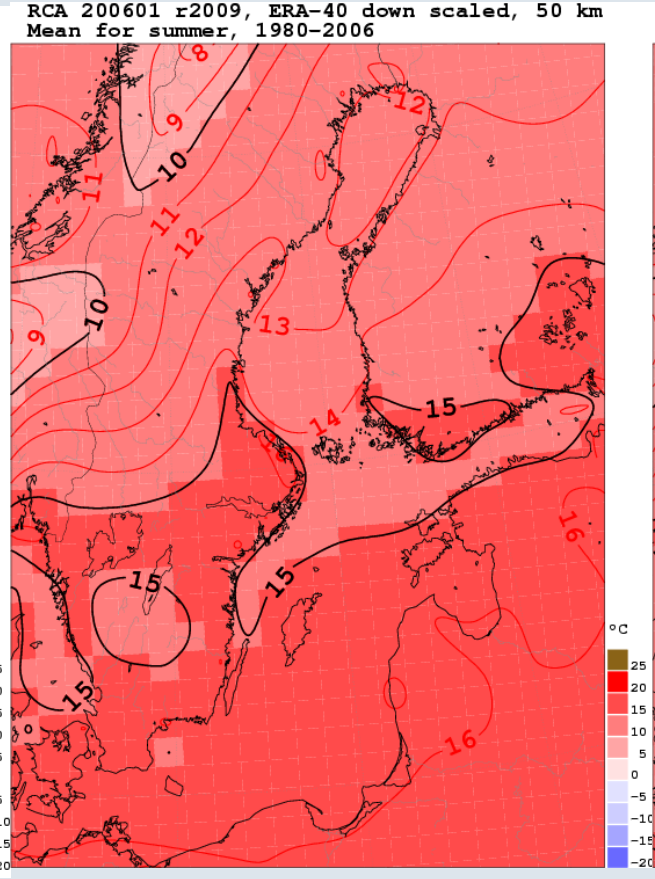


Observations **RCA/ERA40** **RCA/ECHAM5**

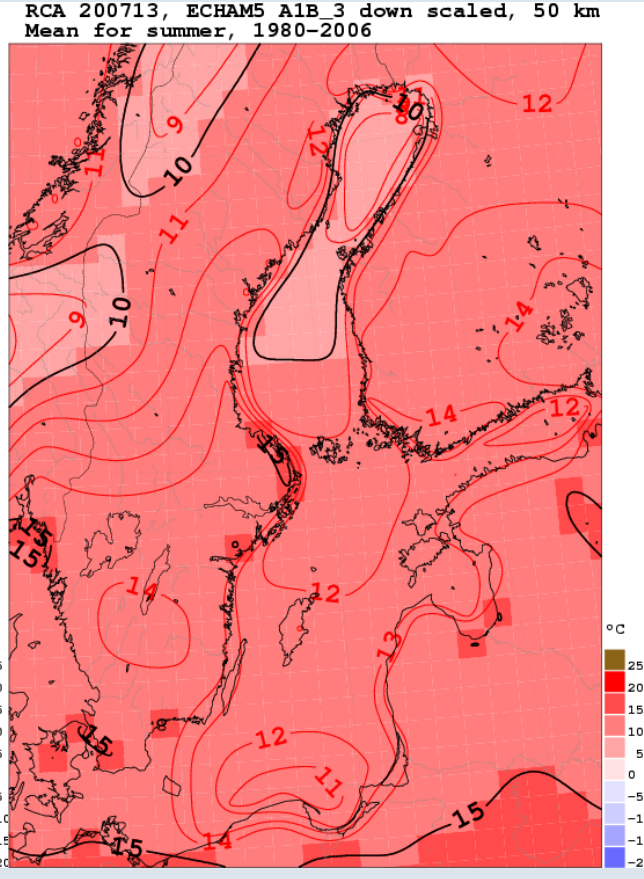
Mean 2m air temperature (summer), 1980-2006



Observations

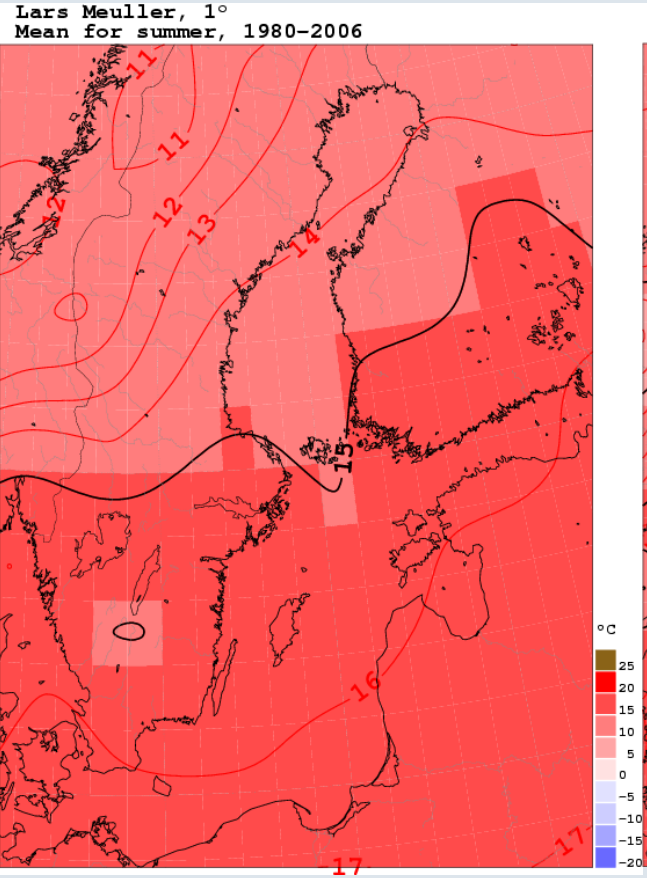


RCA/ERA40

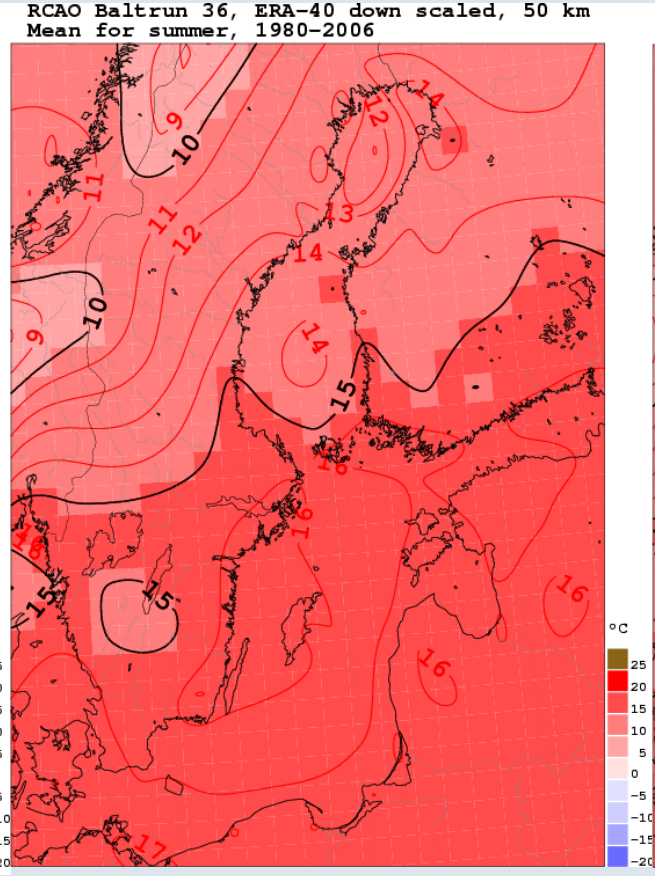


RCA/ECHAM5

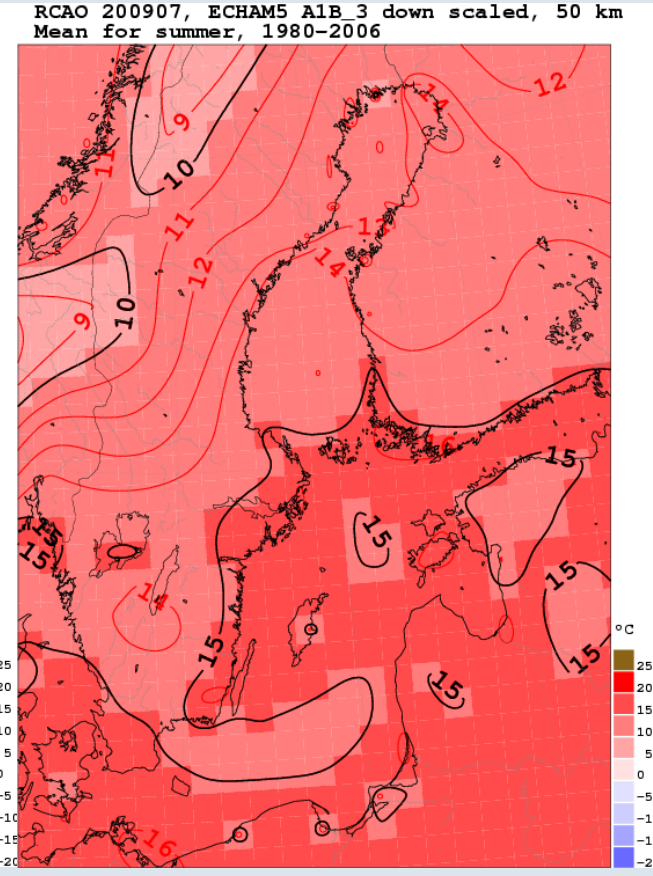
Mean 2m air temperature (summer), 1980-2006



Observations

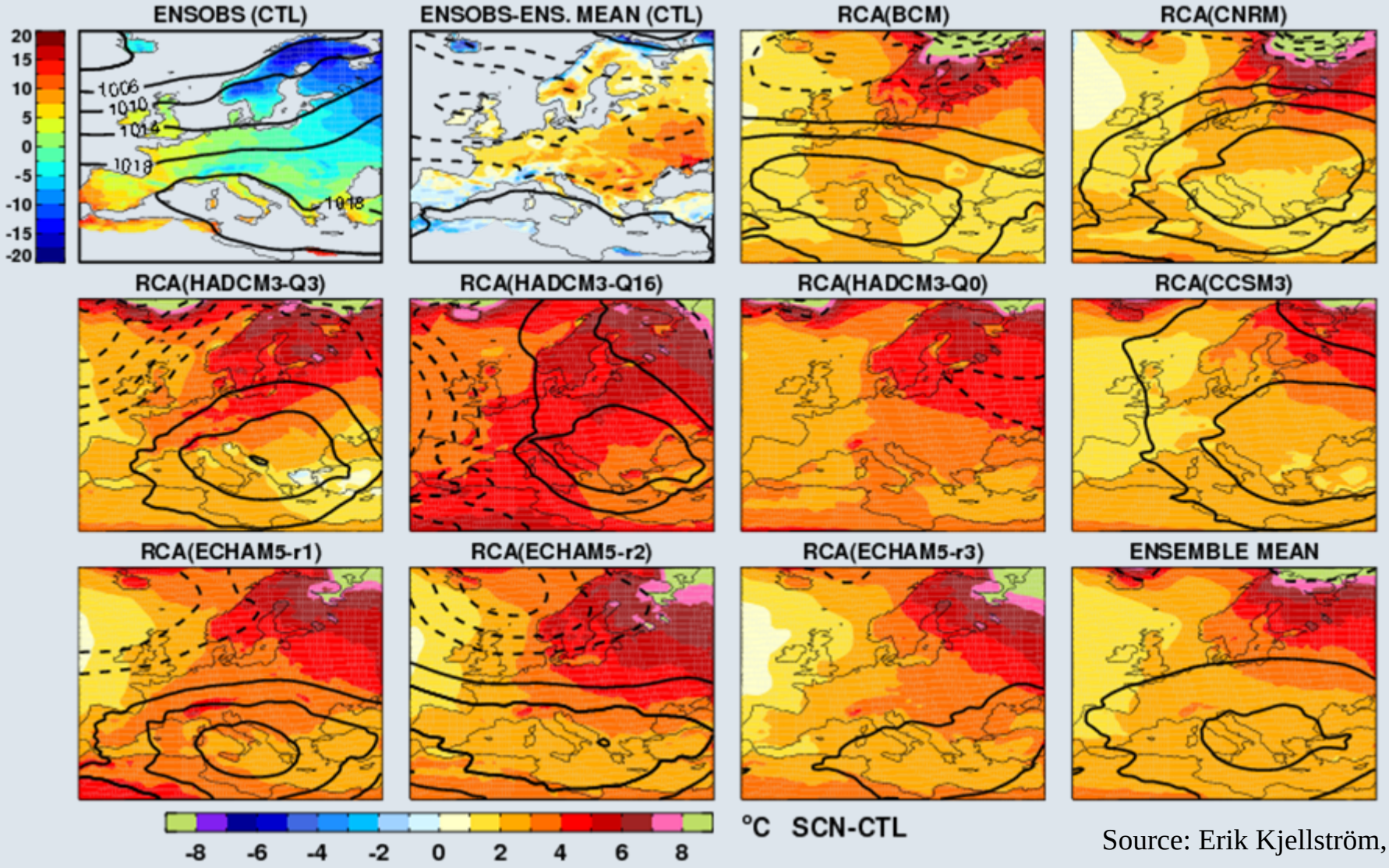


RCAO/ERA40



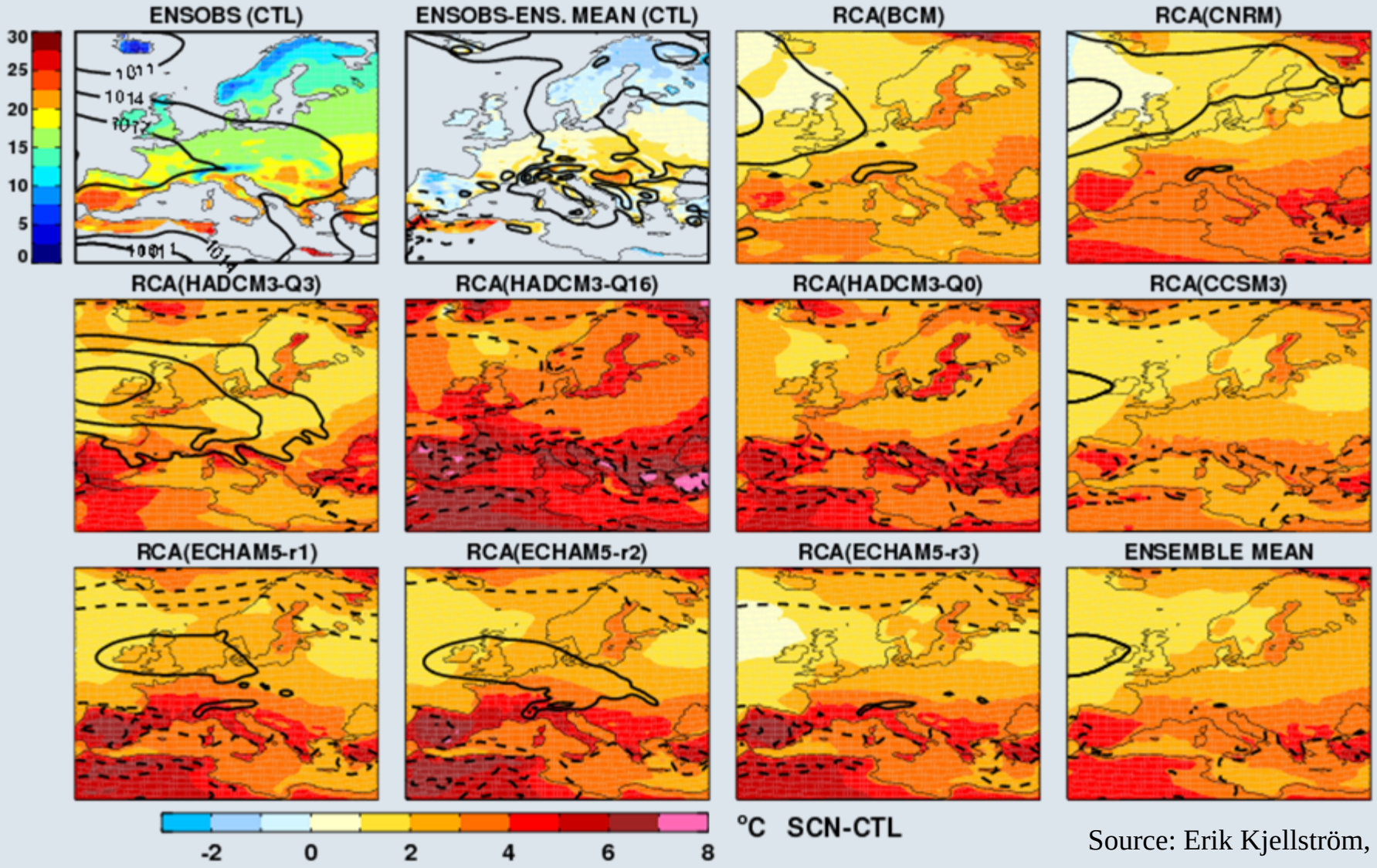
RCAO/ECHAM5

Climate change (2071-2100 vs 1961-1990): winter (DJF) mean temperature and MSLP



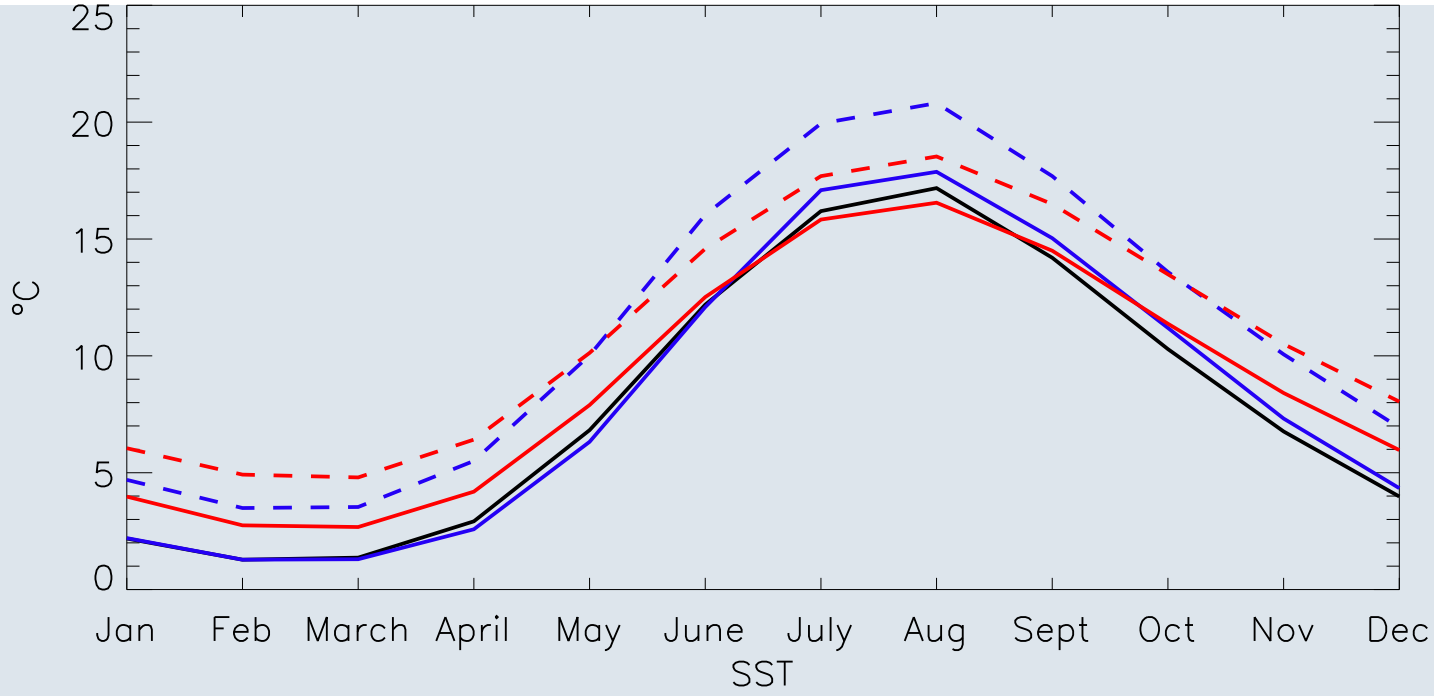
Source: Erik Kjellström, SMHI

Climate change (2071-2100 vs 1961-1990): summer (JJA) mean temperature and MSLP



Source: Erik Kjellström, SMHI

Mean seasonal cycles of SST (in °C) averaged for the Baltic Sea



Black: Hindcast 1961-2007

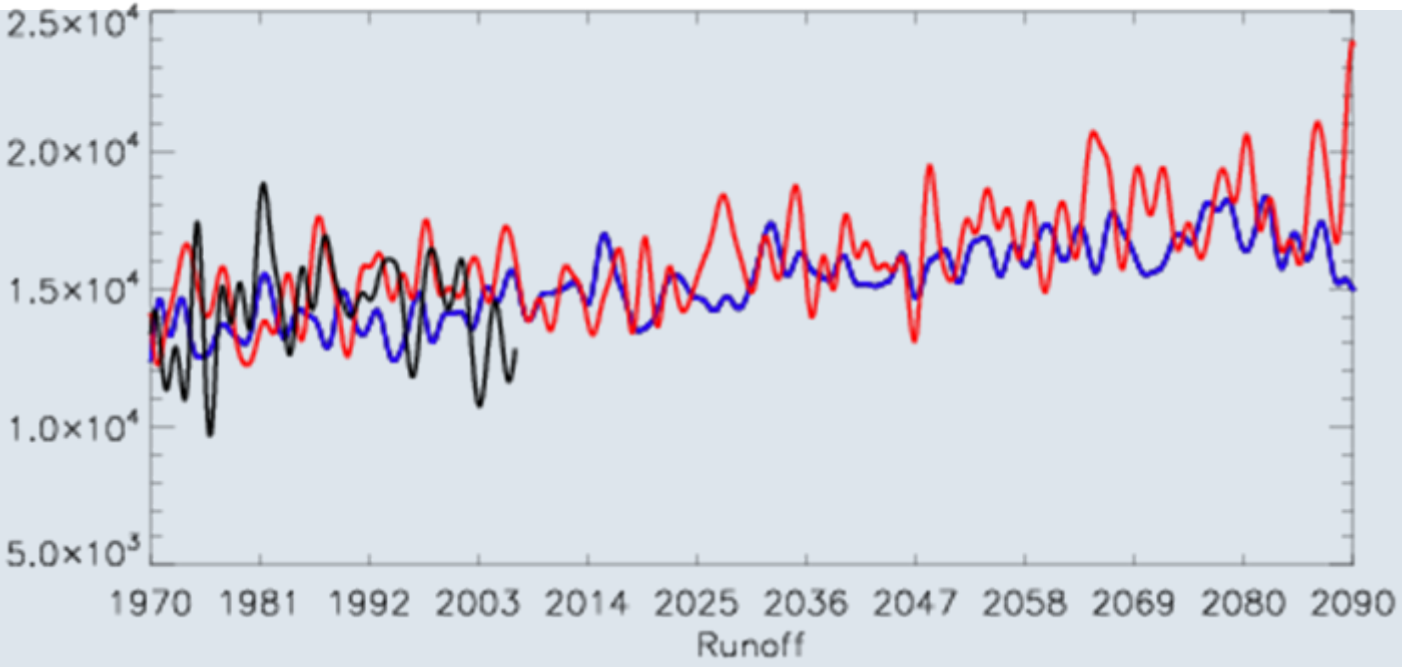
Red: RCAO/ECHAM5 A1B

Blue: RCAO/HadCM3 A1B

Solid: Control period 1970-1999

Dashed: Scenario period 2070-2099

Filtered runoff 1970-2090 (m^3/s)



Black: Observations
Red: RCAO/ECHAM5 A1B
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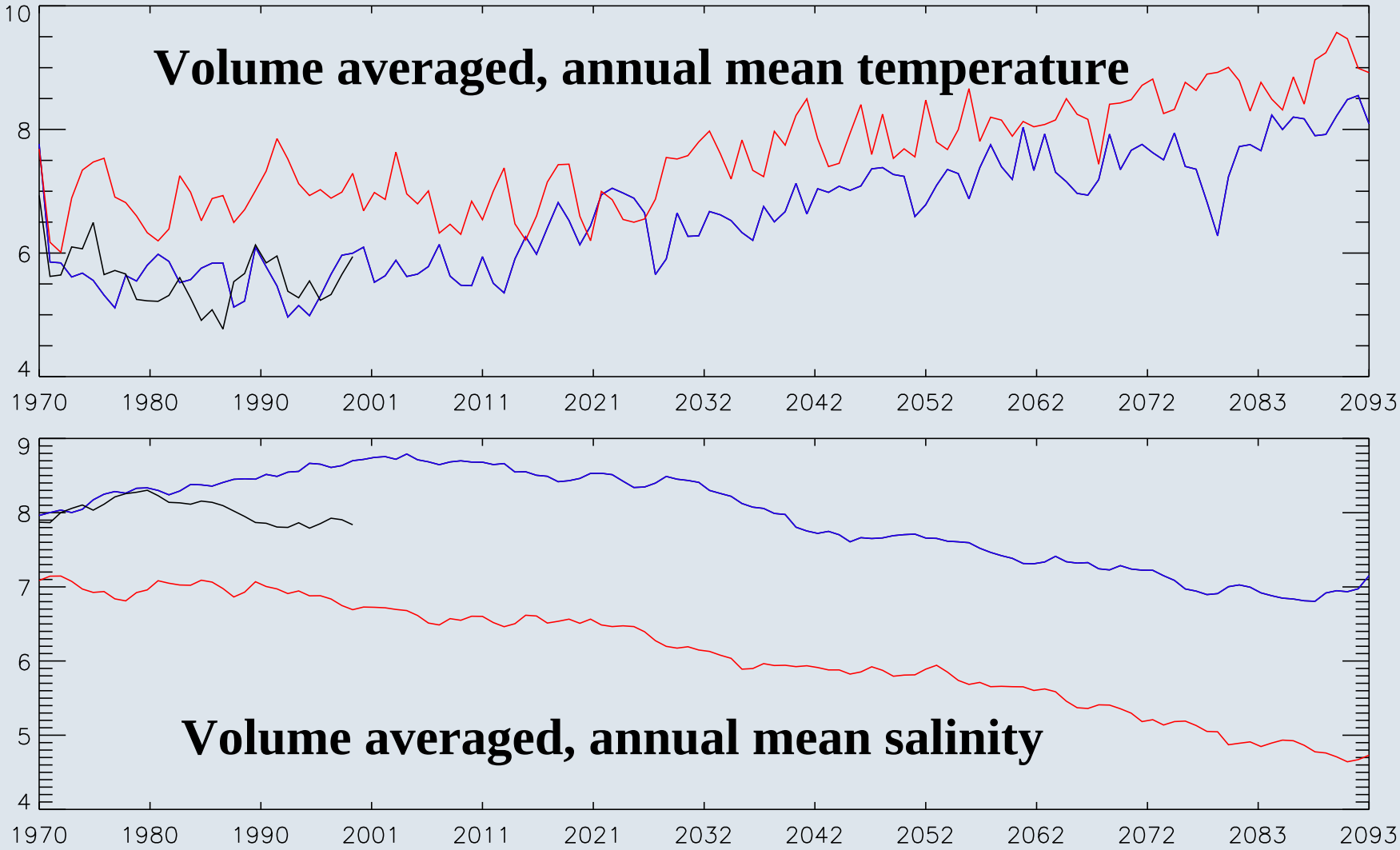
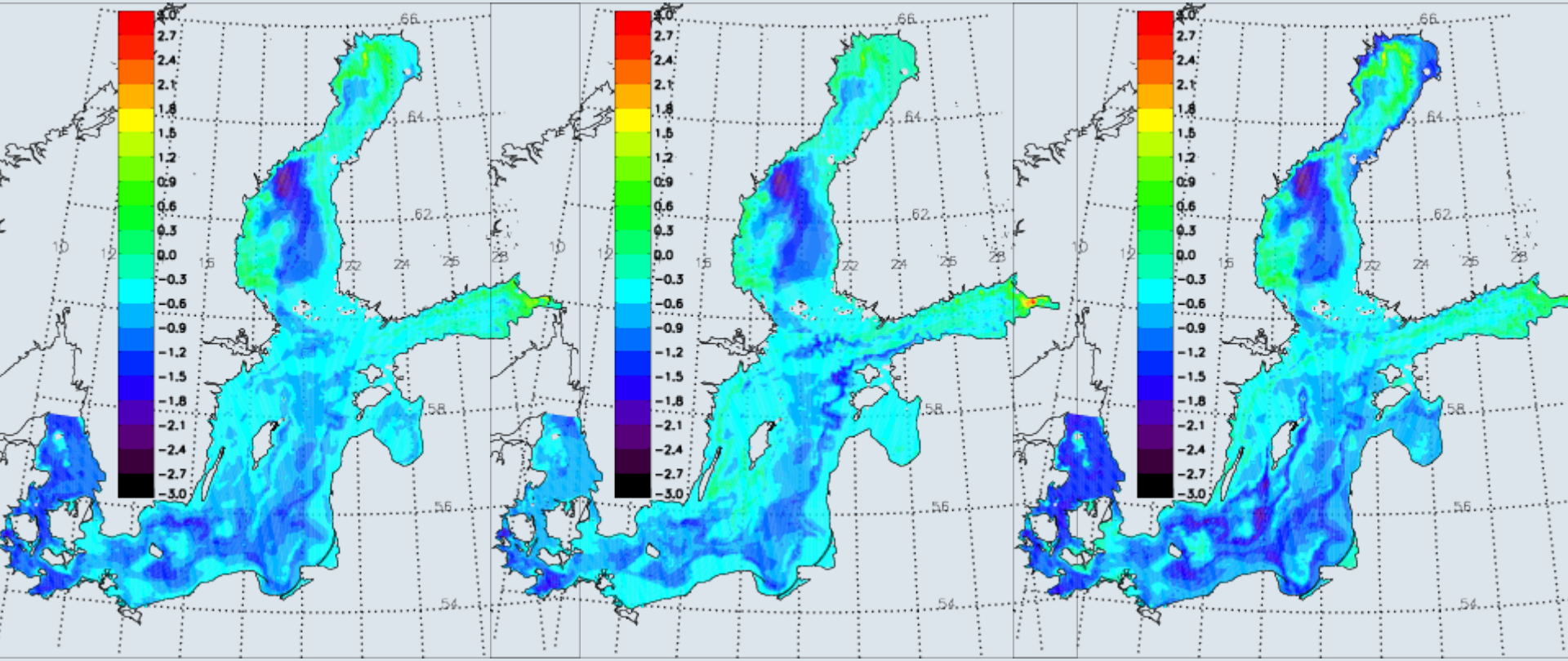
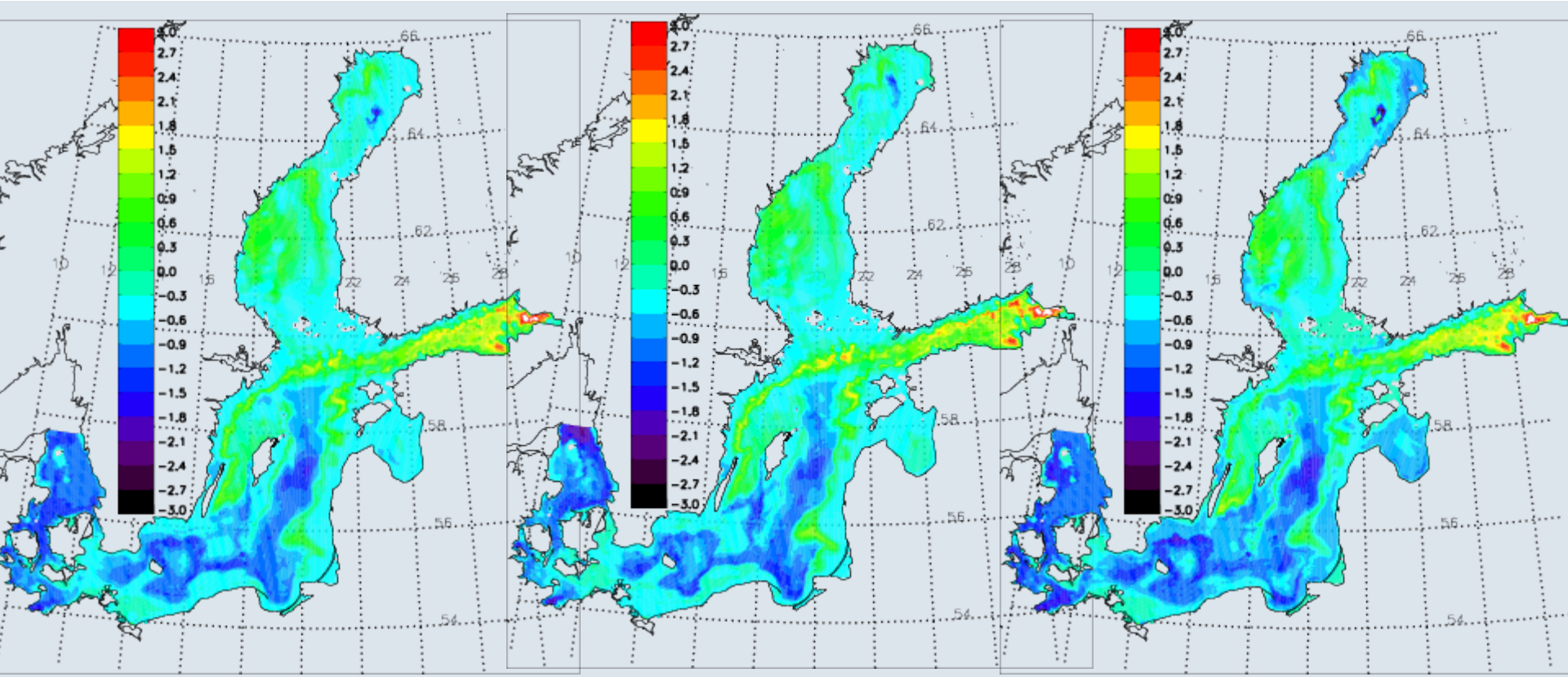


Changes of bottom oxygen concentrations (in ml/l)
RCAO/HadCM3 A1B



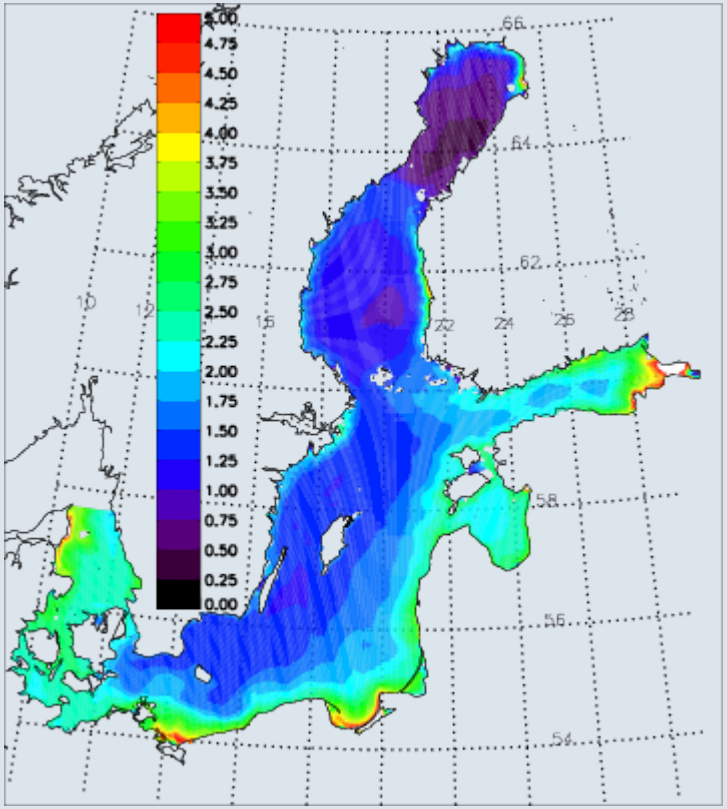
Annual mean **Winter (DJF)** **Summer (JJA)**

Changes of bottom oxygen concentrations (in ml/l)
RCAO/ECHAM5 A1B

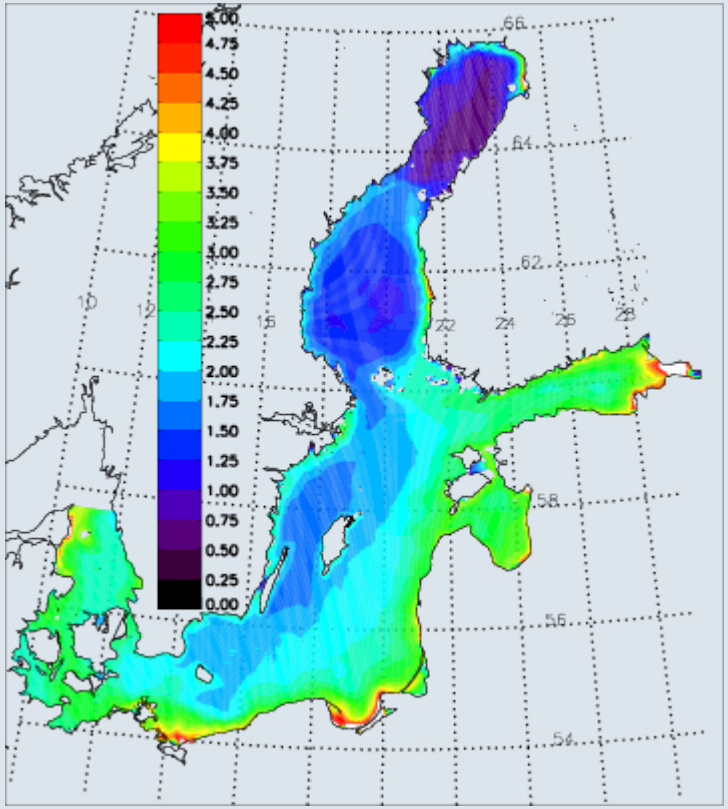


Annual mean **Winter (DJF)** **Summer (JJA)**

Annual mean phytoplankton concentration (in mgChl m^{-3}) vertically averaged over the upper 10 m
HadCM3 A1B

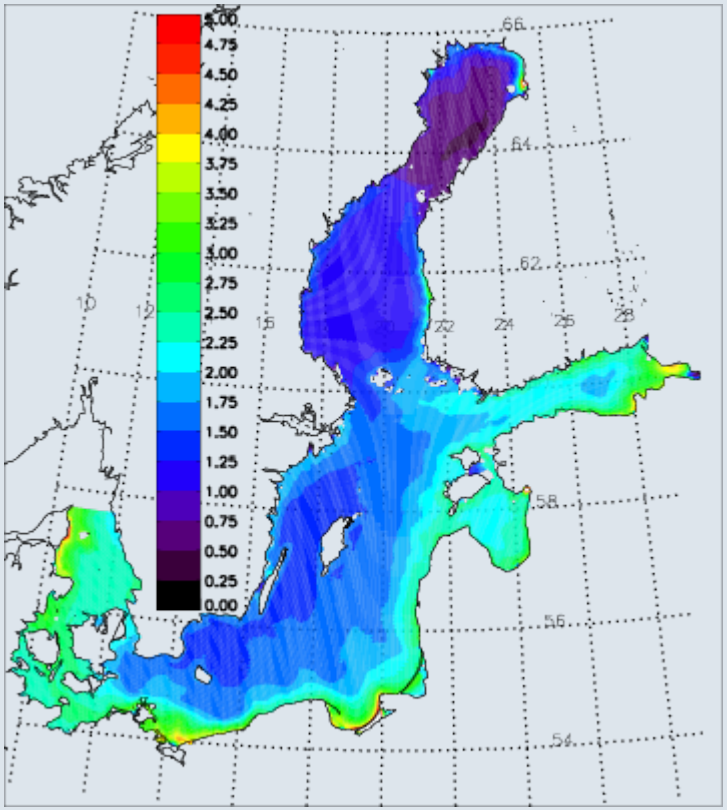


Present climate 1970-1999

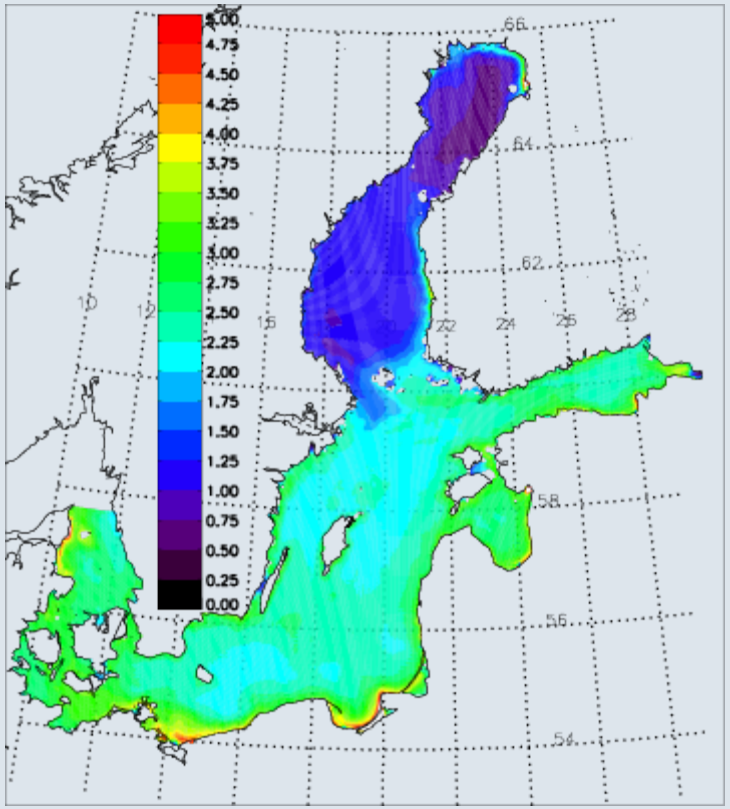


Future climate 2070-2099

Annual mean phytoplankton concentration (in mgChl m^{-3}) vertically averaged over the upper 10 m
ECHAM5 A1B



Present climate 1970-1999



Future climate 2070-2099

Summary

1. The quality of the GCMs differs significantly. As a starting point we have selected ECHAM5 and HadCM3. We performed transient simulations with realistic control climate for the Baltic Sea.

2. Improved summer SSTs using the coupled RCAO model.

3. We found increased runoff but the mean wind speed changes are statistically not significant. Hence salinity decreases are smaller than in earlier scenario simulations.

4. Overall oxygen decrease but slight increases in ECHAM5 driven scenario simulations in intermediate depths.

5. Increased phytoplankton concentrations in both scenario simulations.

6. Next steps: runoff from a hydrological model HYPE, higher resolution in RCA (25 km)

First results based on RCO-SCOBI and IPCC 2001:

1. Future climate might be characterized by increased water temperatures, increased mixing, and (reduced loads) in the Baltic Proper
2. Increased water temperatures => decreased oxygen concentrations in all regions
3. Increased mixing => increased oxygen concentrations below the halocline => reduced winter DIP and reduced denitrification (i.e. increased DIN)
4. Increased water temperature and increased mixing => increased (decreased) phytoplankton concentrations in the south-western (northern) Baltic Proper
5. In future climate the ”business-as-usual in agricultural practices” scenario may have larger impacts than in present climate
6. The BSAP will likely reduce the phytoplankton concentrations also in future climate