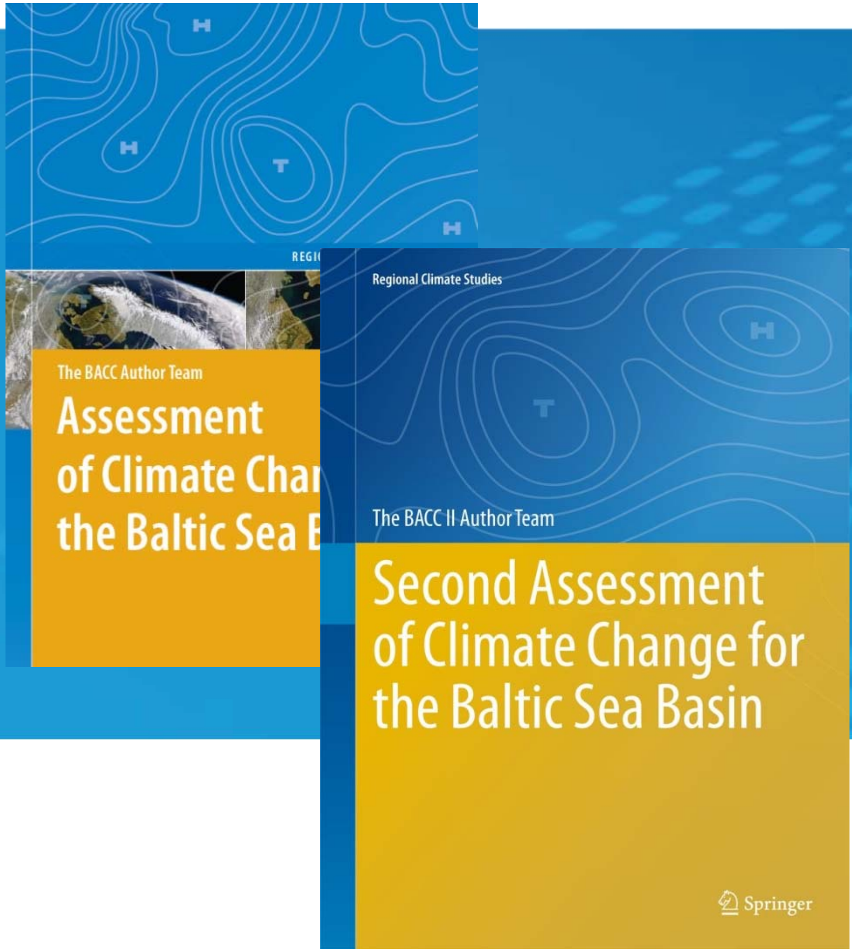
ECCA, Copenhagen 14 May 2015

Hot-spot Baltic Sea – Observed and expected climate change and impacts on Europe's first macro-region

Results from the new BACC Report

Baltic Earth
Earth System Science for the Baltic Sea Region



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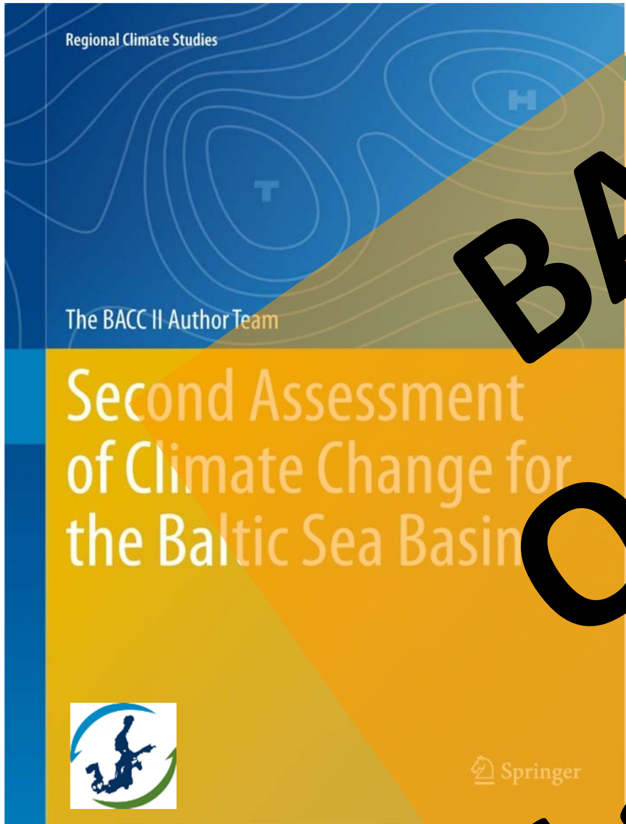
Baltic Earth Assessment of Climate Change for the Baltic Sea region (2015)

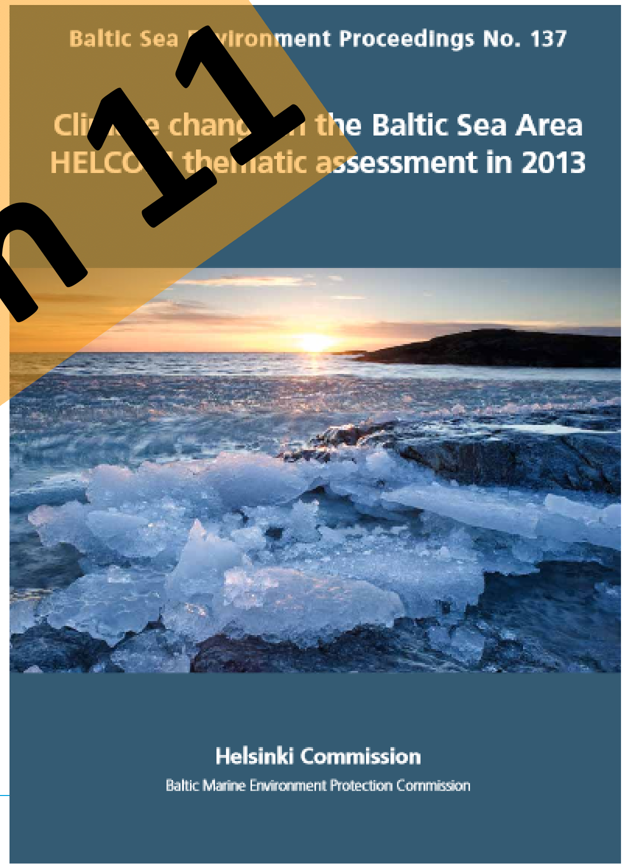


Second Assessment of Climate Change for the Baltic Sea region (BACC II)

New book following the format of BACC I as OPEN ACCESS, 7 years after

- What we currently know about climate change and its impacts in the Baltic Sea region
- Compiled by 141 authors from 12 countries
- Science Steering Group
- Peer reviewed
- Open Access with Springer

BACC II Out Now! Launch today at 13:15 Auditorium 11



Planned based on BACC II:

Extended summaries of the scientific material

→ In all 9 languages of the Baltic Sea region plus English (Danish, Swedish, Finnish, Russian, Estonian, Latvian, Lithuanian, Polish, German)

→ Understandable for non-scientists

→ Emphasizing on regional conditions

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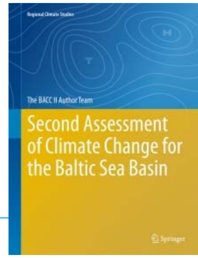
Recent changes …



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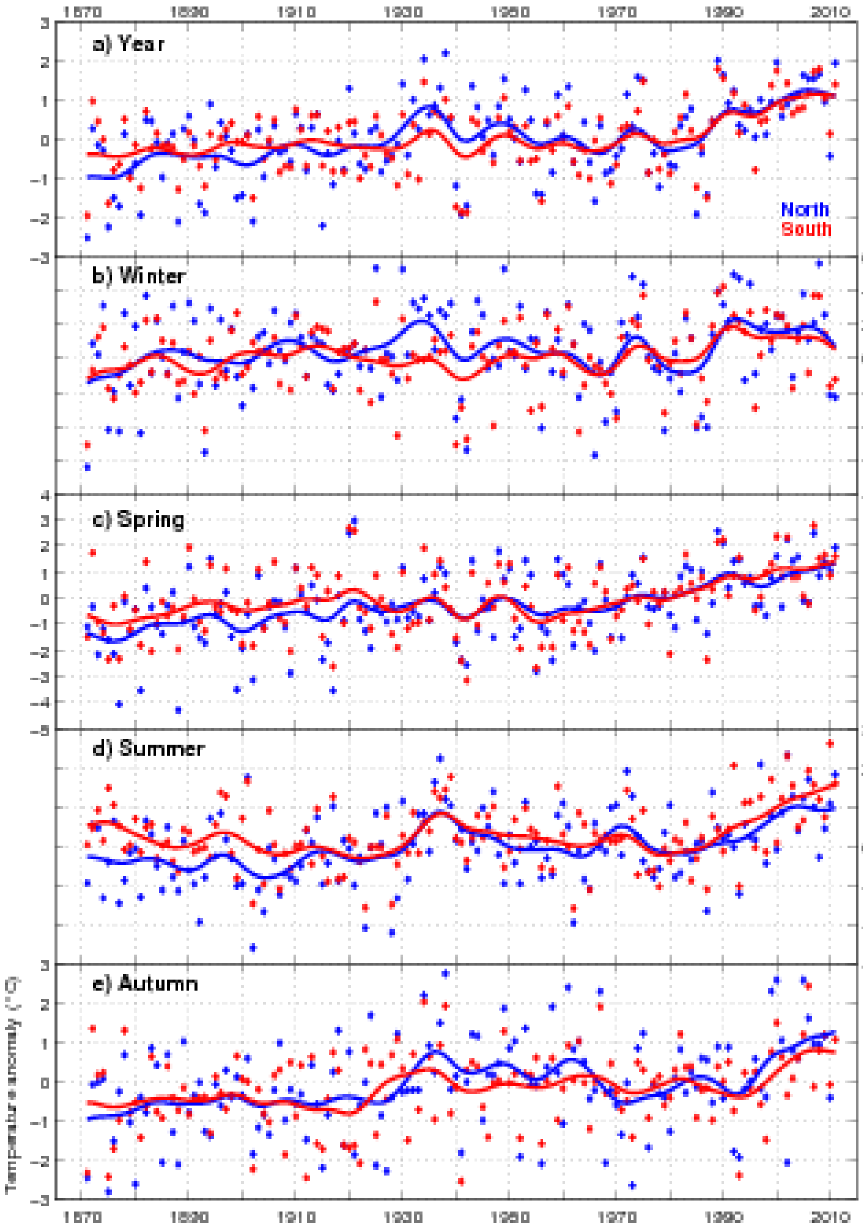


Air temperature

→ **Warming trend detectable, regionally and saisonally differences**

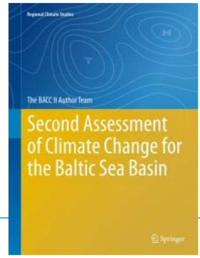
Table 4.1 Linear surface air temperature trends (°C per decade) for 1871–2011 in the Baltic Sea basin. Trends shown in bold are significant at the $p < 0.05$ level. The trends were also tested by the non-parametric Mann-Kendall test. The results were consistent with the linear trend test. Data from the CRUTEM3v dataset (Brohan et al. 2006)

Data sets	Annual	Winter	Spring	Summer	Autumn
Northern area (north of 60° N)	**0.11**	0.10	**0.15**	**0.08**	**0.10**
Southern area (south of 60° N)	**0.08**	**0.10**	**0.10**	**0.04**	**0.07**

Fig. 4.11 Annual and seasonal mean surface air temperature anomalies (relative to 1960–1991) for the Baltic Sea basin 1871–2011, calculated from 5° by 5° latitude, longitude box average taken from the CRUTEM3v dataset (Brohan et al. 2006) based on land stations (from top to bottom: (a) annual, (b) winter (DJF), (c) spring (MAM), (d) summer (JJA), (e) autumn (SON)). Blue comprises the Baltic Sea basin north of 60° N, and red south of 60° N. The dots represent individual years and the smoothed curves (Gaussian filter, σ = 3) highlight variability on timescales longer than 10 years

BACC 2 Chapter 4

Recent changes …



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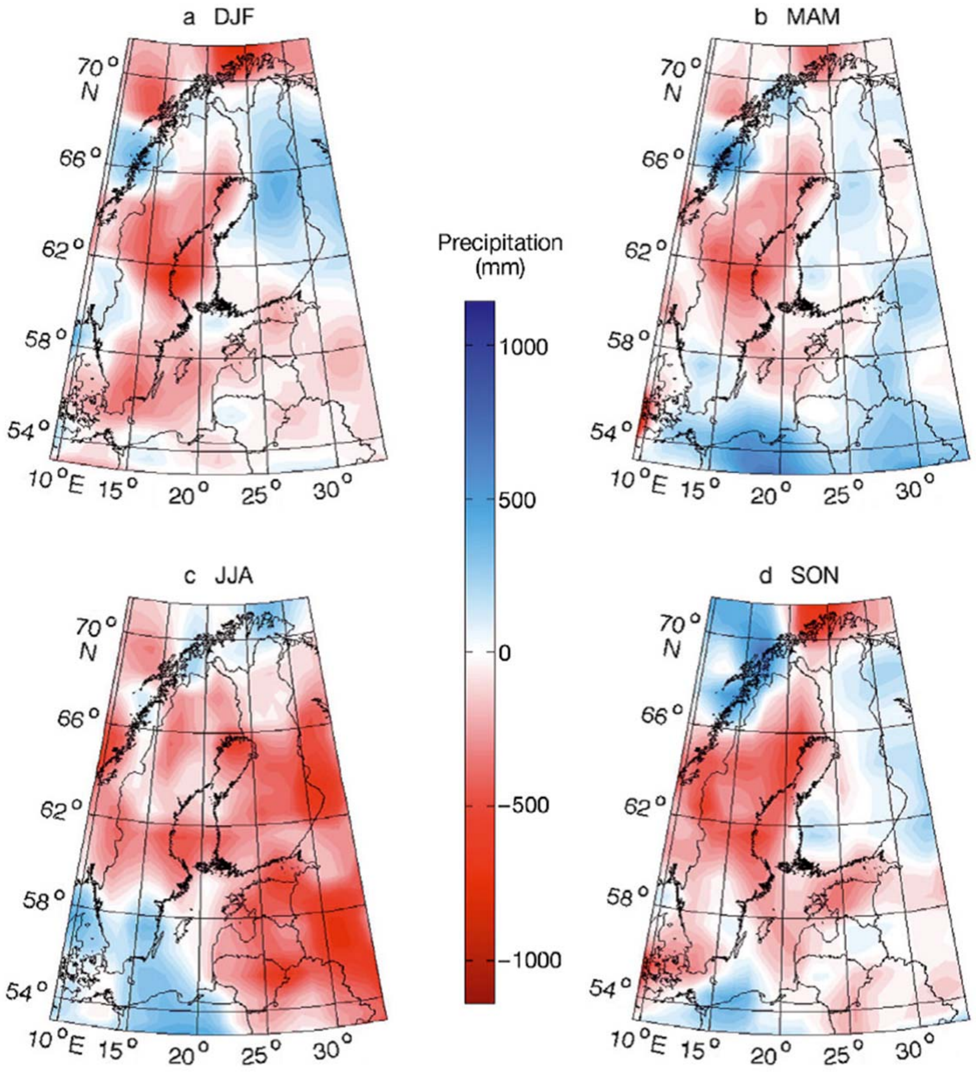


Fig. 4.16 Change in total precipitation between 1994–2008 and 1979–1993 by season based on SMHI data (Lehmann et al. 2011)

Rain

→ **Large regional and seasonal differences**

→ **Large decadal variability**

→ **General slight increase in yearly avaerages since 1990**

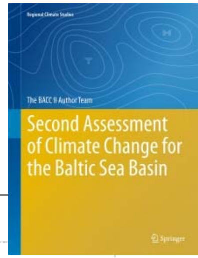
→ **Slight increase in extreme precipitation events**

BACC 2

Chapter 4

Recent changes …

Wind



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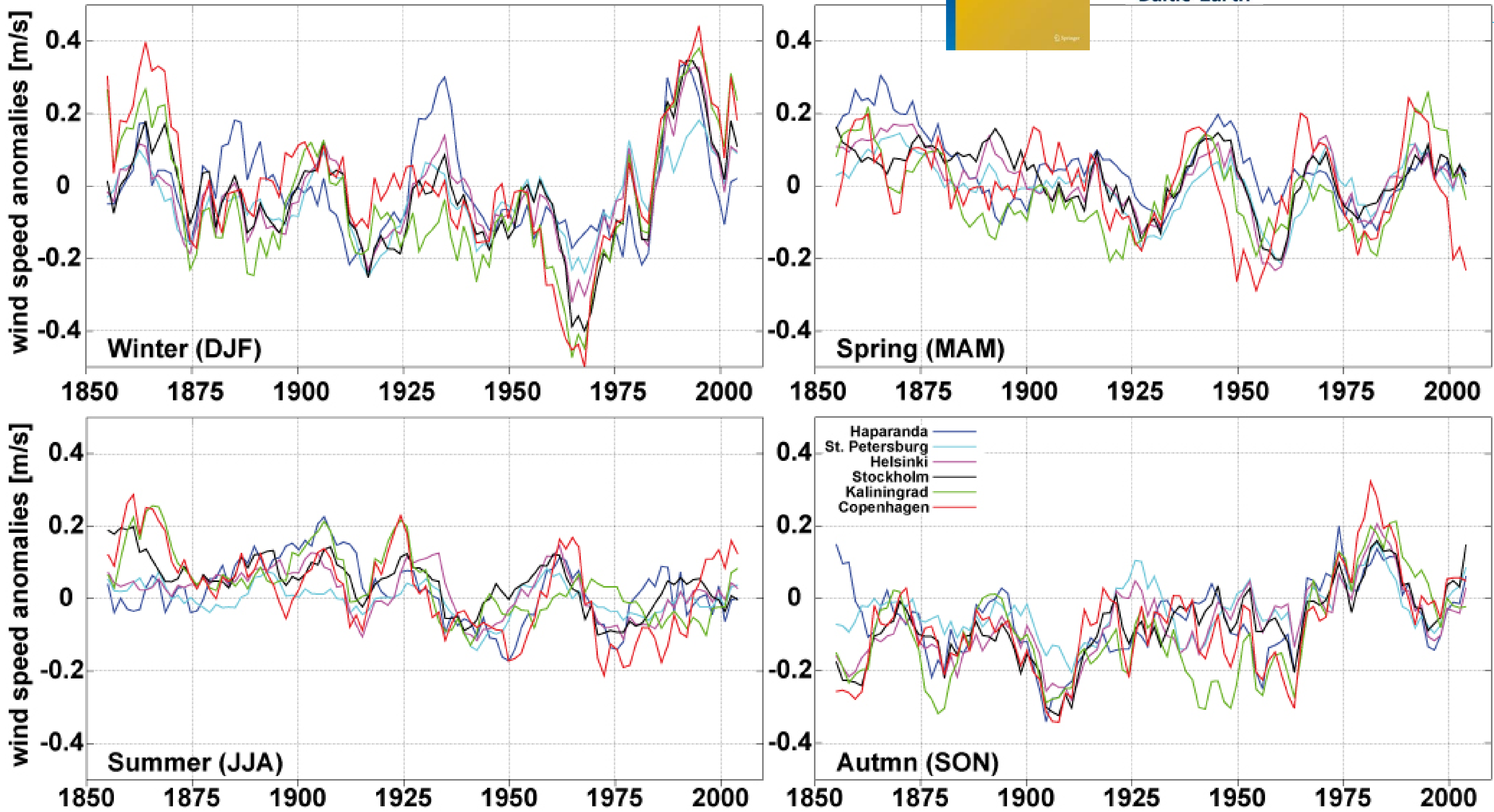
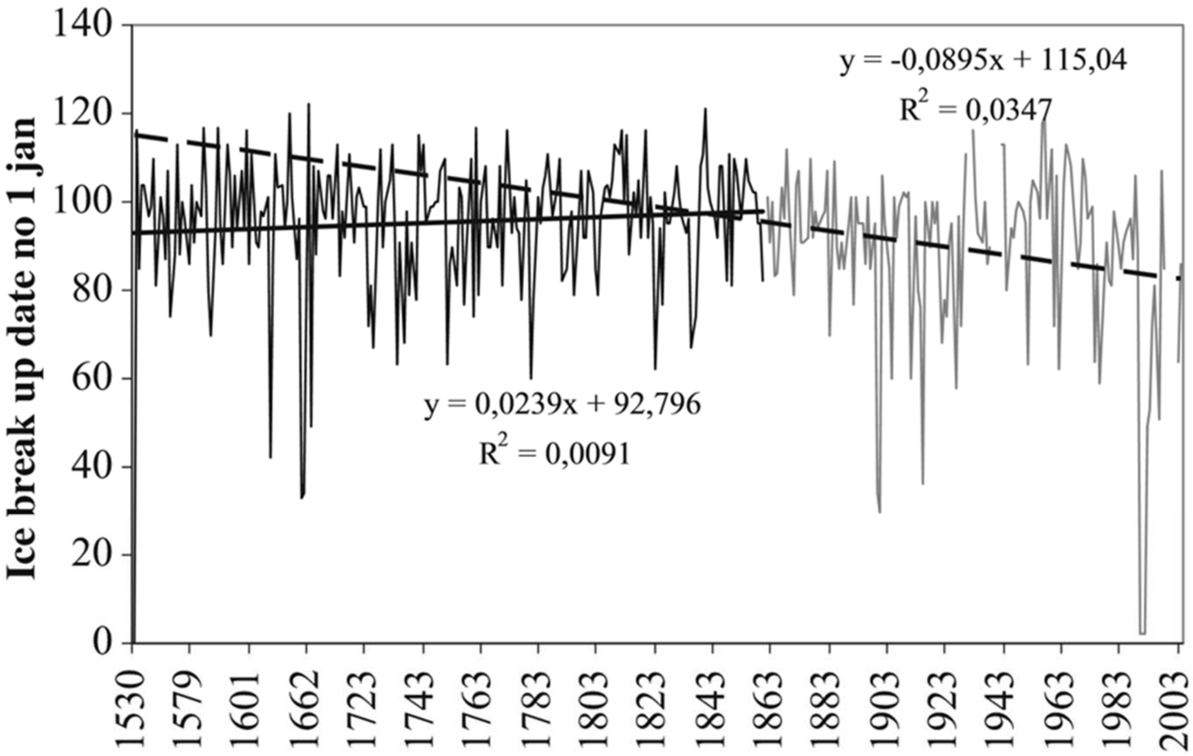
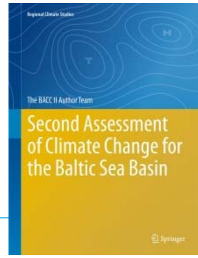


Sliding decadal (11-y) mean seasonal wind speed anomalies for the Baltic Sea regions for 1850-2009. Anomalies are calculated by subtracting the mean of 1958-2007. Time series are drawn from the gridded fields of HiResAFF (Schenk and Zorita 2011, 2012). Grid points are selected in the closest vicinity of Haparanda, Saint Petersburg, Helsinki, Stockholm, Kaliningrad and Copenhagen.

→ **Large variability, decadal but no long-term trends in storminess**

BACC 2
Chapter 4





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Recent changes …

Ice on rivers and lakes

Fig. 5.19 Time series of ice break-up dates on River Daugava (dashed line shows trend from 1860 to 2003 and continuous line from 1530 to 1859) (Kļaviņš et al. 2009)

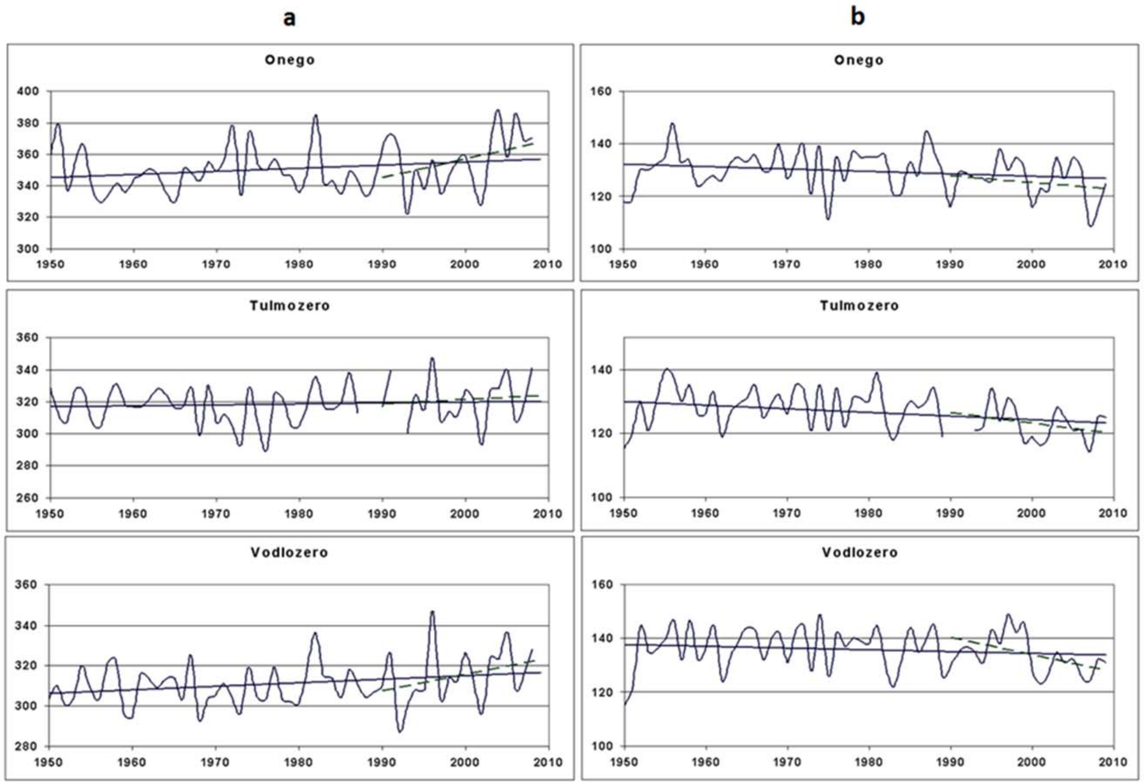
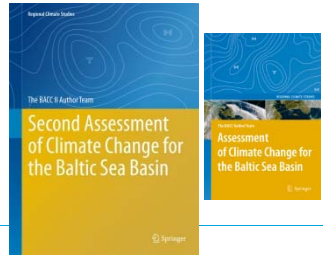


Fig. 5.21 Date of a) freeze-up and b) break-up on a large lake (Onego), a middle size lake (Vodlozero) and a small lake (Tulmozero) for 1950–2009. The linear trends for 1950–2009 and 1990–2009 are shown by the solid and dashed line, respectively (Efremova and Palshin 2011)

→ **Ice freeze-up and breakup dates have changed**

eu

Recent changes … Sea water temperatures



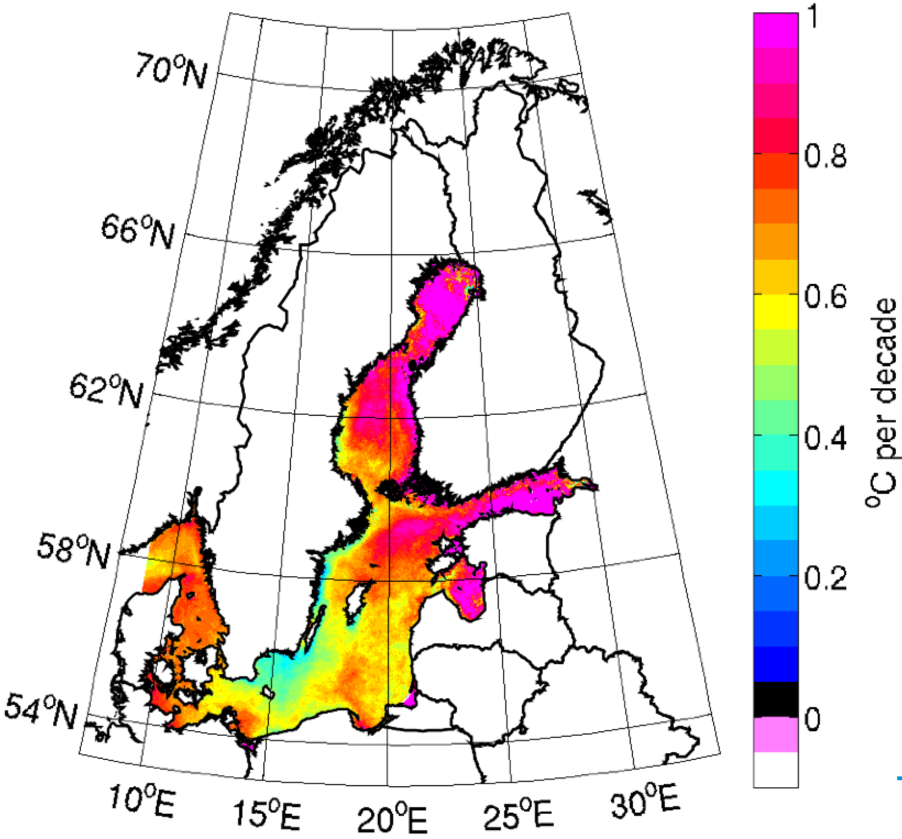
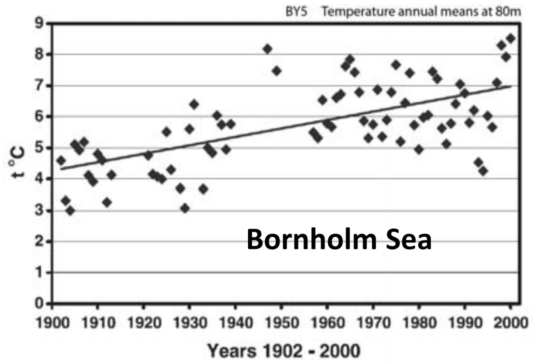
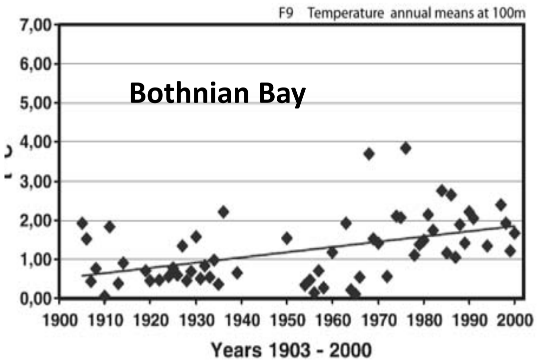


Fig. 7.2 Linear trend in annual mean sea surface temperature based on infrared satellite data (1990–2008) provided by the Federal Maritime and Hydrographic Agency (BSH), Hamburg (Lehmann et al. 2011)





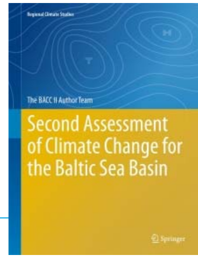
→ **Since 1990 strong surface warming in Bothian Bay and Gulf of Finland**

→ **Detectable warming of the Baltic Sea, surface and deep water**

BACC Ch. 3
BACC 2
Chapter 7

Recent changes …

Sea ice cover



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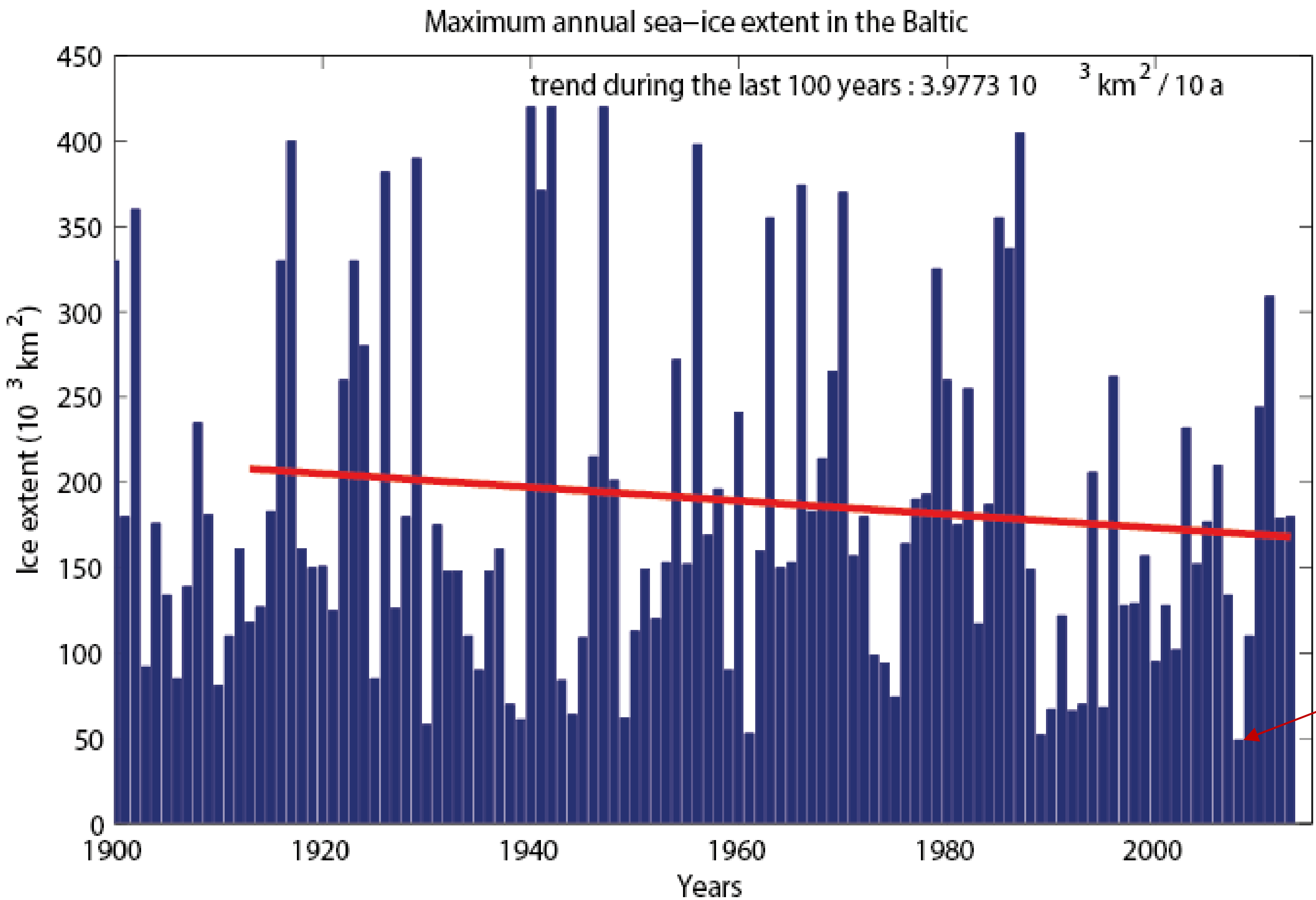
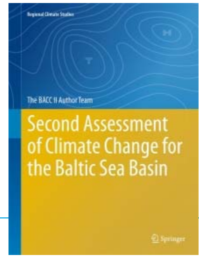


→ **Frequency of mild ice winters has increased**

Winter 2007/2008 lowest ever recorded ice cover

Fig. 8.3 The maximum extent of sea-ice cover in the Baltic Sea, 1900–2012. The red line shows a long-term declining trend of ~2% per decade

BACC 2 Chapter 8



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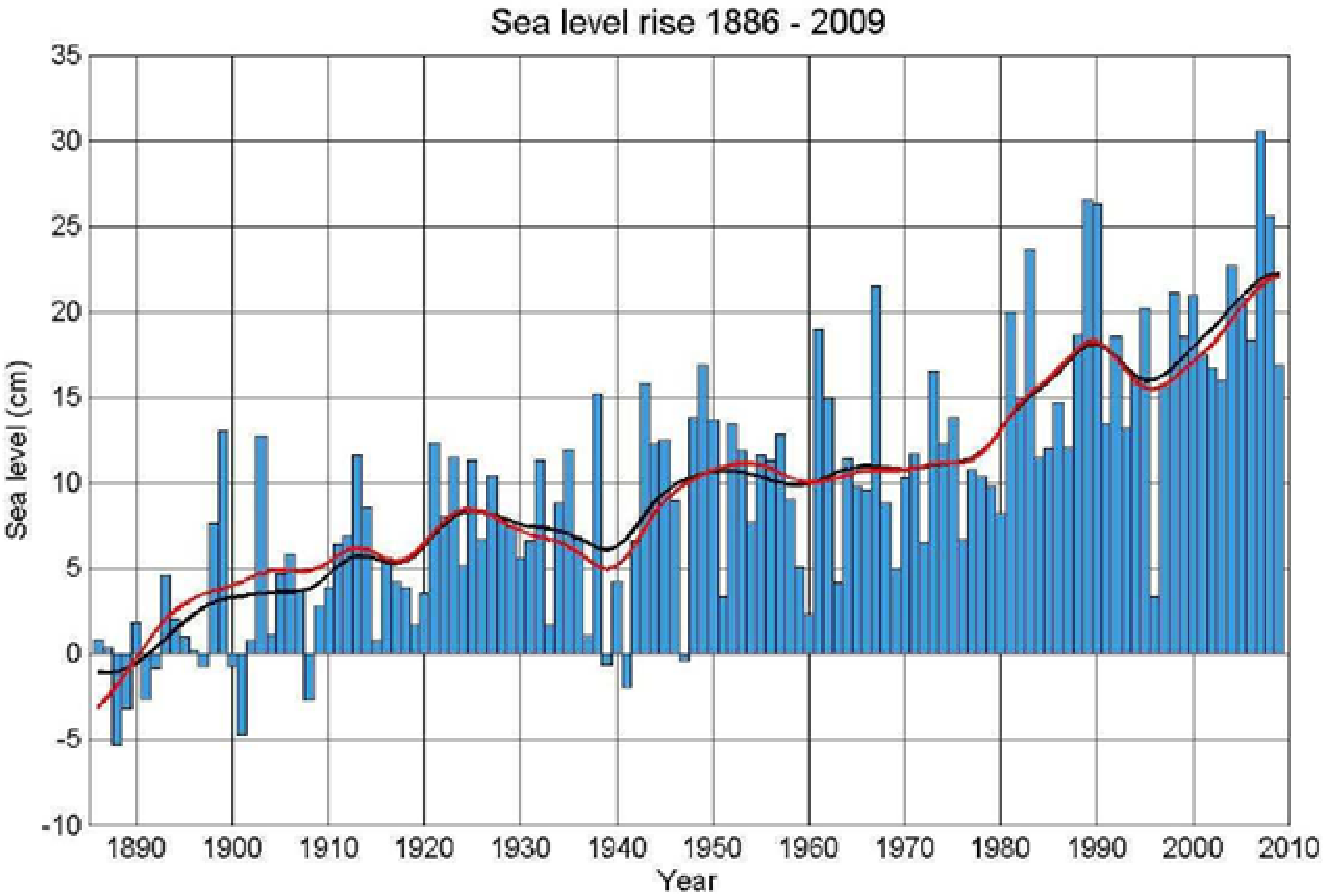
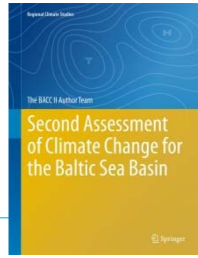


Fig. 9.5 Annual sea level means averaged for 14 Swedish sea level records corrected for land uplift (shown in the right table for each location) and compared to the 1886 level. Black line: time-filtered version together with the filtered Stockholm sea level time series (red line) (Hammarklint 2009)

→ **Current estimations for the Baltic Sea coast: 1,3 mm/yr – 1,8 mm/yr, comparable with the global rise (1,7 mm/yr ± 0,5)**

Projected changes until 2100… Air temperature



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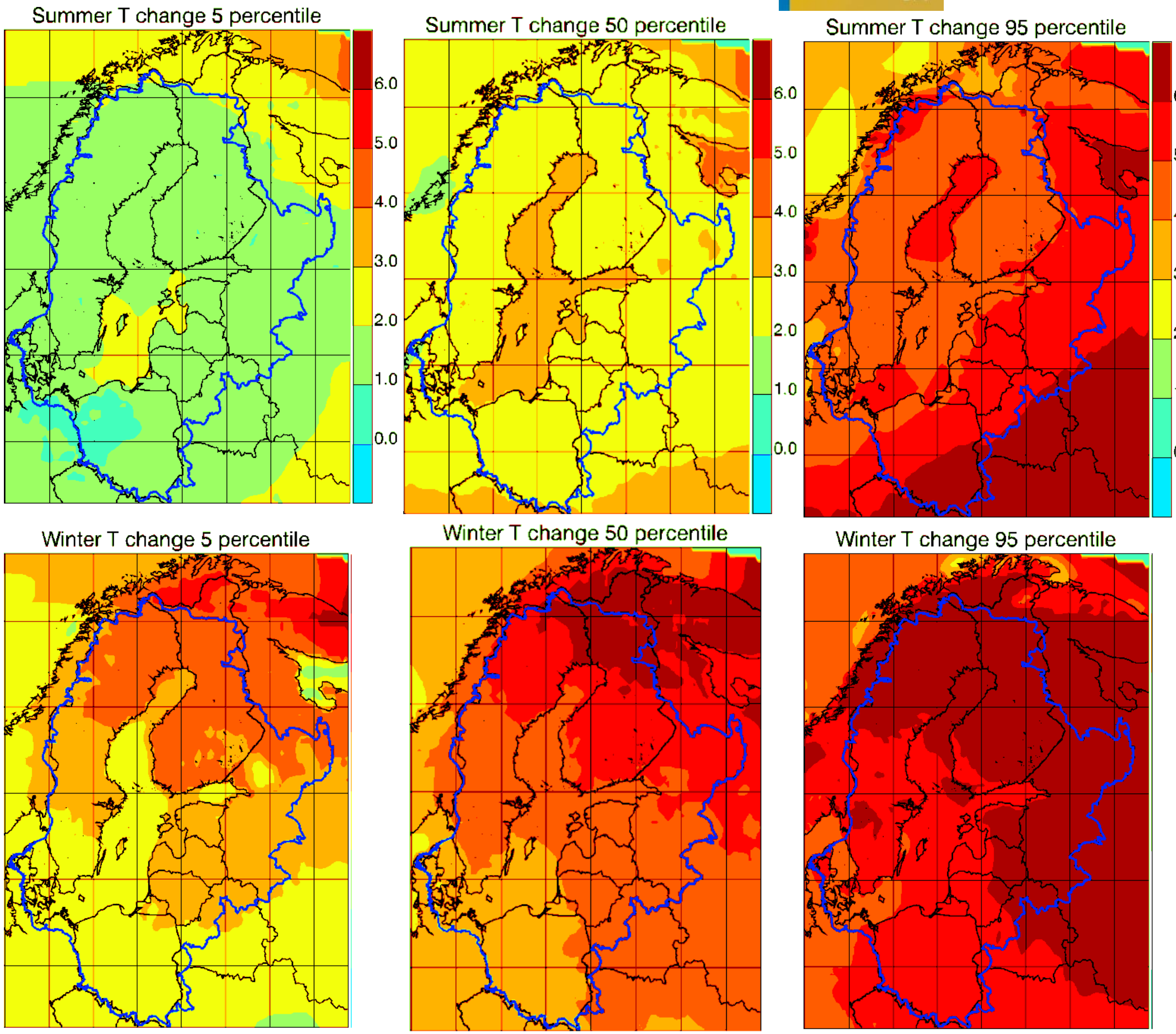
Summer

Winter



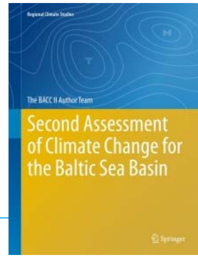
13 RCM simulations from the ENSEMBLES project change between 1961-1990 and 2070-2099

→ **Overall warming expected (4-8°C in Winter; 1.5-4°C in Summer)**

→ **Strongest in the North**

BACC 2 Chapter 11

Projected changes until 2100… Rain



Baltic Earth

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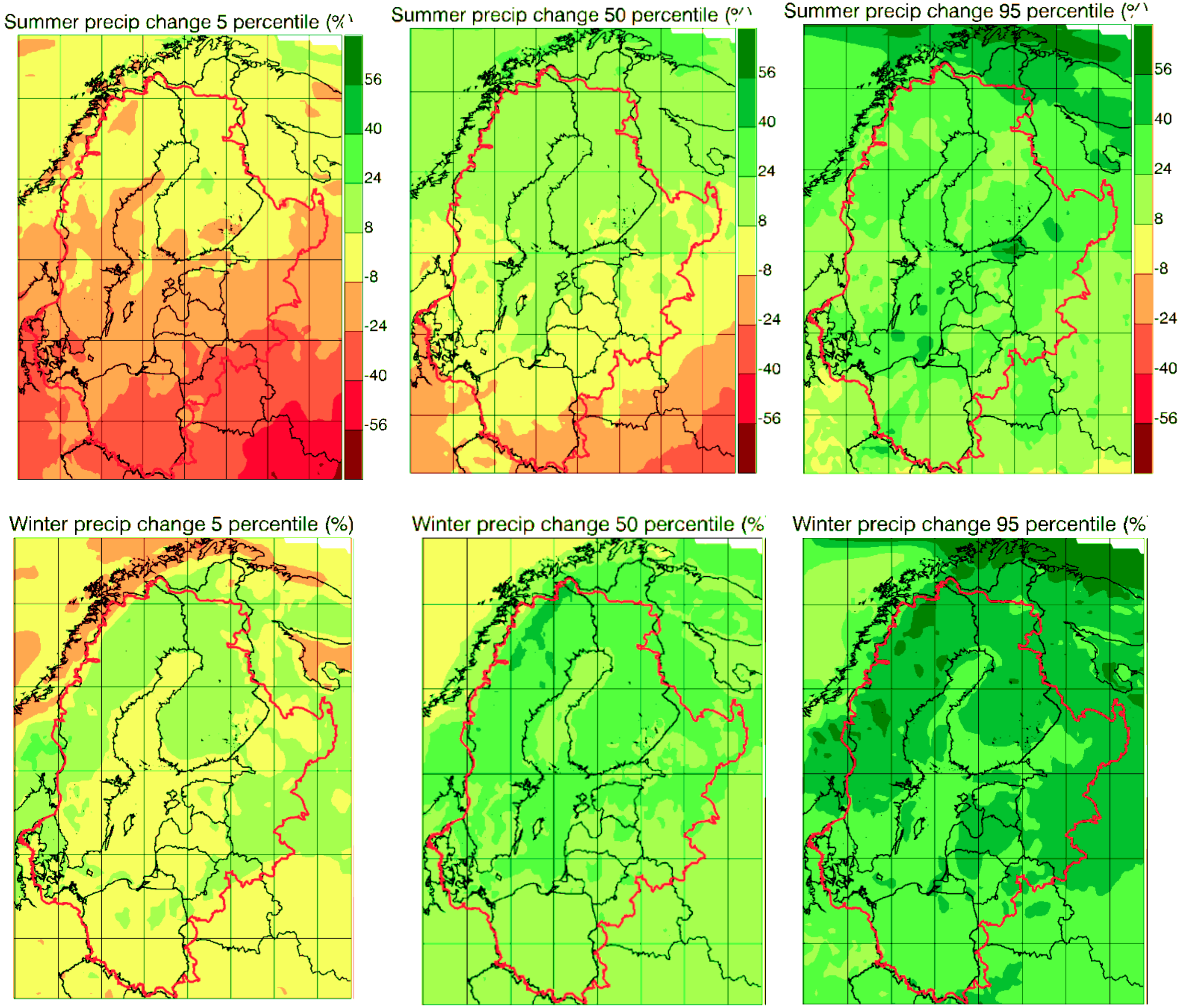
Summer

Winter



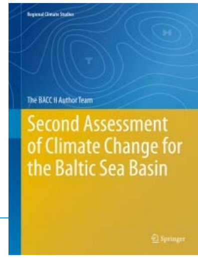
13 RCM simulations from the ENSEMBLES project change between 1961-1990 and 2070-2099

→ **Generally wetter**

→ **Possibly dryer in summer and in the south**

BACC 2 Chapter 11

Projected changes until 2100… Wind



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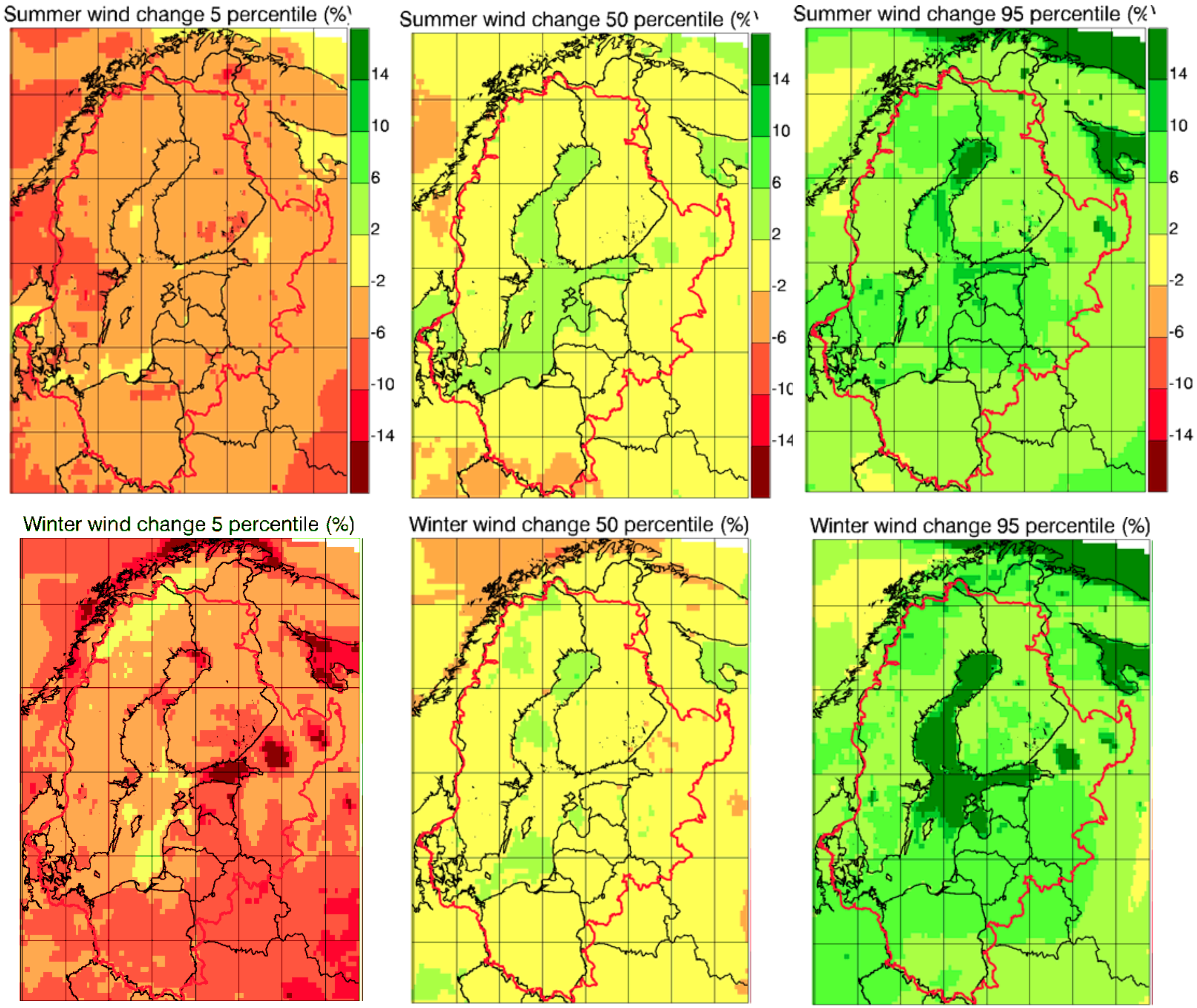
Summer

Winter



13 RCM simulations from the ENSEMBLES project change between 1961-1990 and 2070-2099

→ No clear trend

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Projected changes until 2100… Runoff

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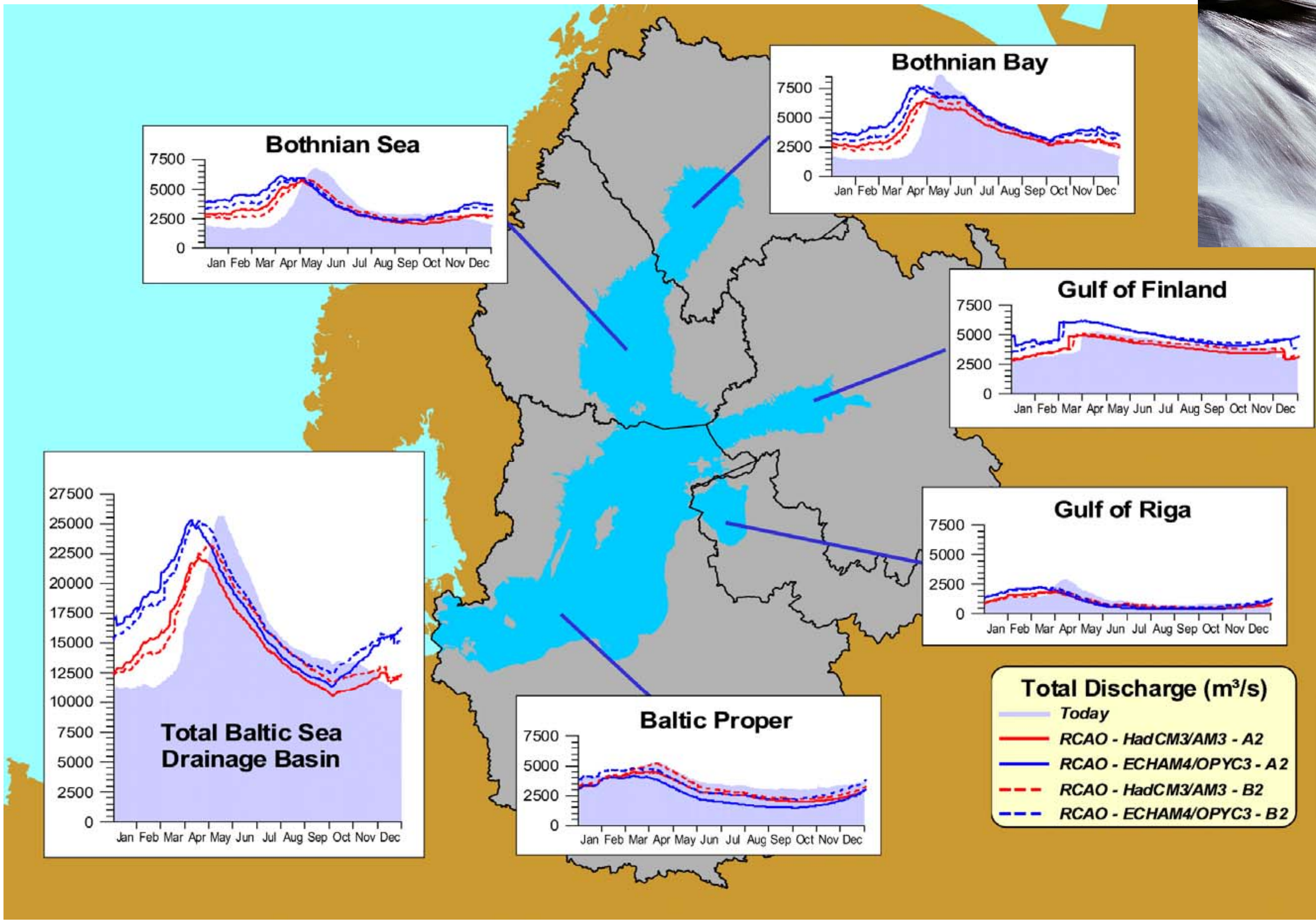


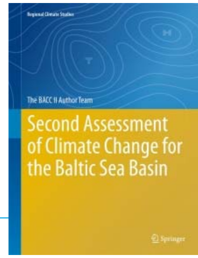
→ More runoff expected (+15 bis +22%)

→ earlier peaks

→ Decreasing salinity?

BACC Ch. 4

Projected changes until 2100... Sea Water



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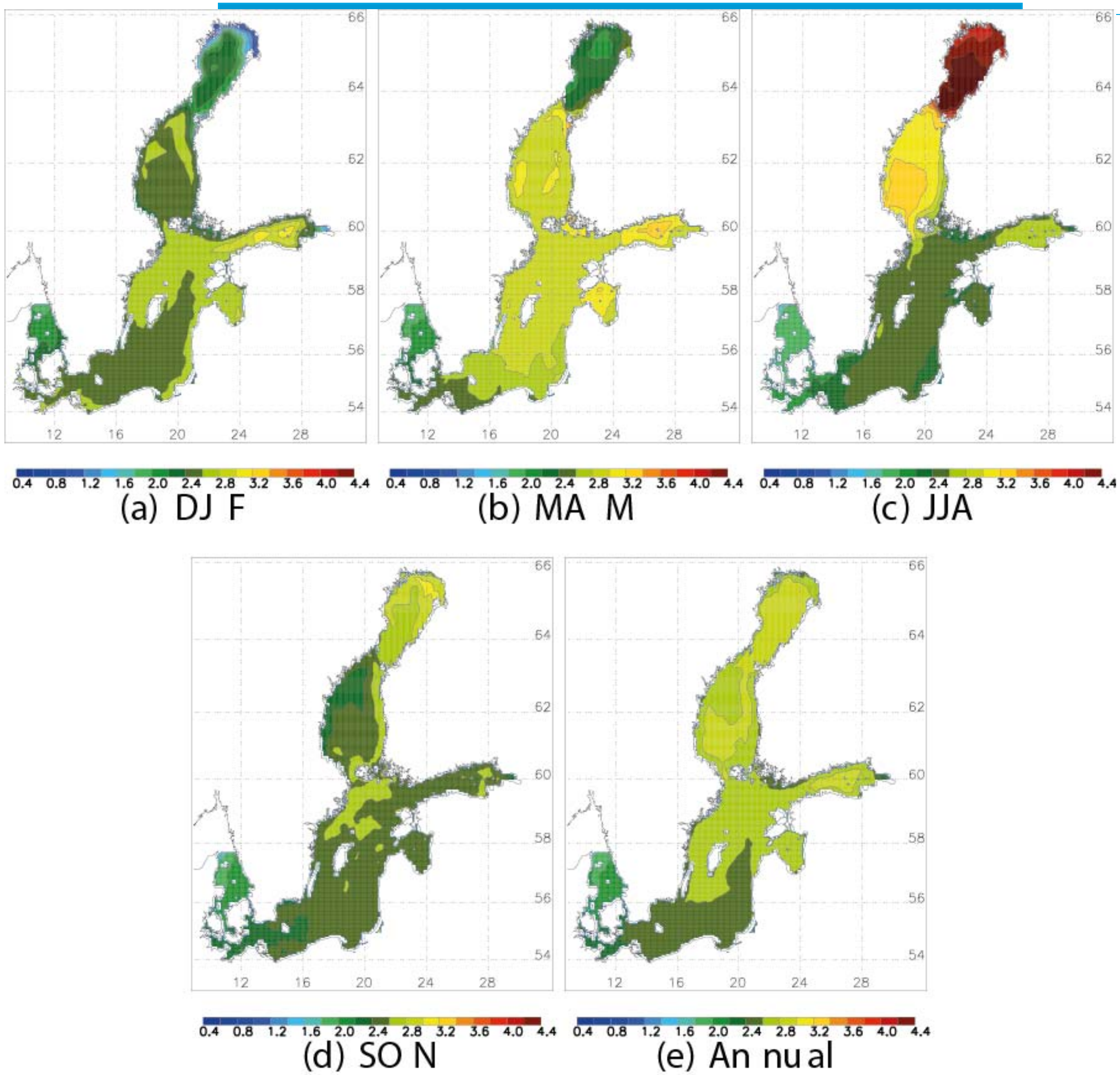


Fig. 13.2 Projected change in seasonal (DJF, MAM, JJA, SON) and annual mean ensemble average sea-surface temperatures for 2069–2098 relative to a baseline of 1978–2007. See Meier et al. (2012a)

Sea Surface Temperatures

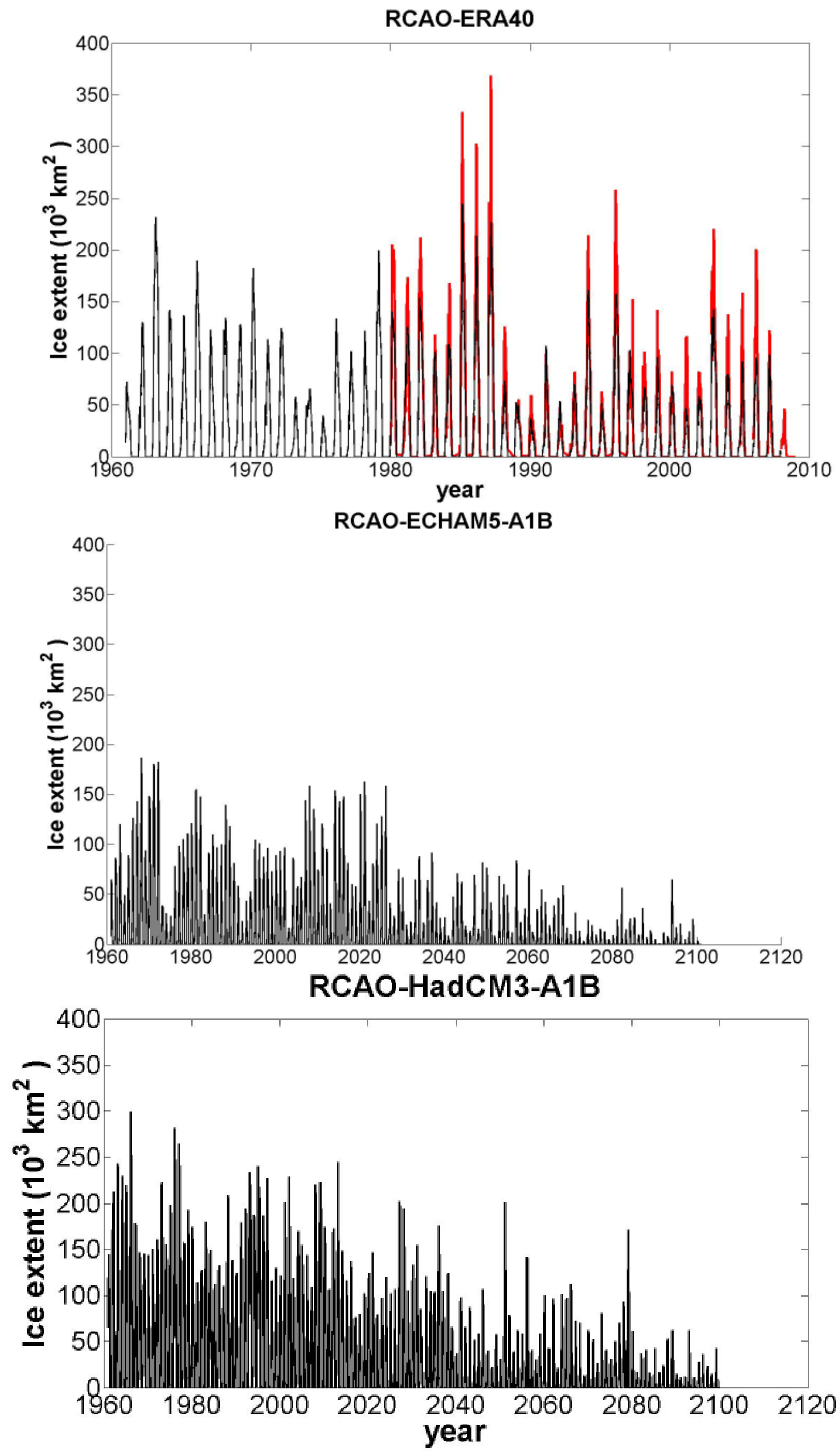
→ **Temperatures:**

Projected increase of sea surface temperatures, in the summer in the north up to 4°C, deep water temperatures projected to increase up to 2°C

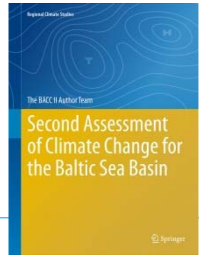
→ **Salinity:**

Changes uniform across seasons, small reduction in the northern and central parts, larger in the Kattegat and Skagerrak

BACC 2 Chapter 13



Projected changes until 2100…



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Sea ice extent

→ **Strong decrease of sea ice extent projected (50 – 80 %)**

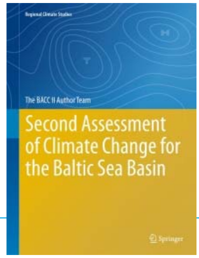
→ **Shortened ice season expected**

Fig. 13.6 Sea-ice extent as function of time for 1961–2007 and 1961–2100 in hindcast and scenario simulations, respectively (left panels): observations (red), model results (black). Shown are results from RCAO-ERA40, RCAO-ECHAM5-r3-A1B and RCAO-HadCM3-ref-A1B using a horizontal resolution of 50 km for the atmosphere model (Meier et al. 2011d)

BACC 2

Chapter 13

Projected changes until 2100… Sea level rise



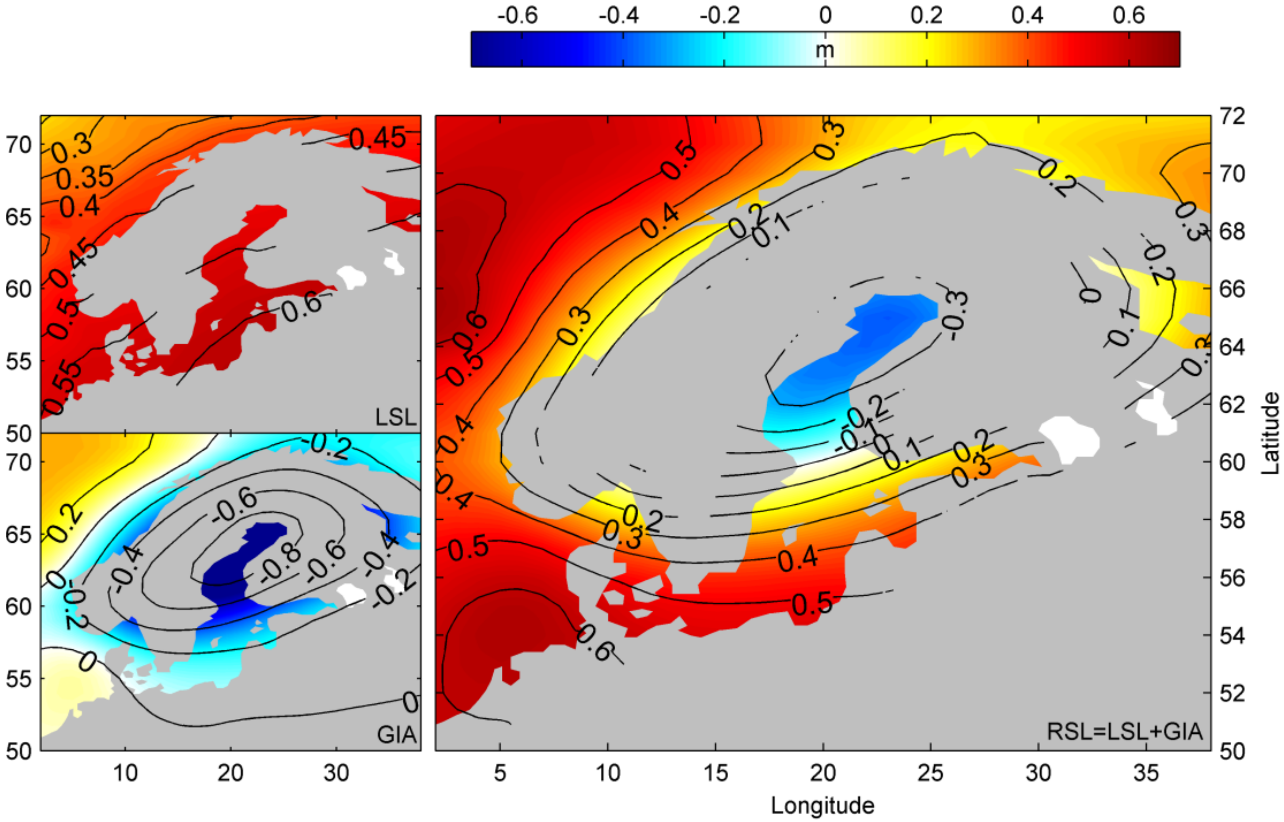


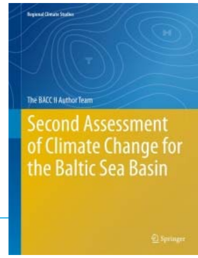
Fig. 14.3 Right panel shows the projected regional sea-level rise for 2090–2099 relative to the 1990–1999 baseline under the SRES A1B scenario, decomposed into local sea-level rise (upper left) and glacial isostatic adjustment (lower left; Hill et al. 2010). There may be additional local sources of vertical land movement that should be considered in adaptation

→ **IPCC AR5 Global projections range 0,20 – 0,82 m depending on emission scenario**

→ **Estimation for the Baltic Sea 0.7 ± 0.30 m based on the SRES A1B emission scenario**

BACC 2 Chapter 14

Impacts



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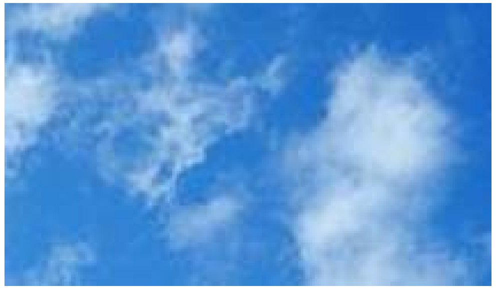
Atmosphere



→ Main changes in **air pollution** are due to **changes in emissions rather than to climate change**

→ Future developments depend strongly on **policy developments**

BACC 2 Chapter 15

Land ecosystems

→ **Longer** vegetation period

→ **Northward** migration of species (**fragmentation** of spaces is **limiting**)

→ **New** species

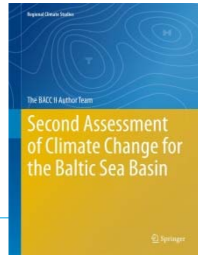
BACC Ch. 4,
BACC 2, Ch 16
BACC 2, Ch 21

→ **Forest growth** in the North projected to **increase** (+22%)

→ Smaller increase in the south (+8%), Water imiting

→ **Positive effects on crop yield**, especially for winter crops

Impacts



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- → Climate change **is one among many factors** for many observed changes (eutrophication, land use, pollution, overfishing)
- → Complex interactions between climate change and other anthropogenic factors

Possible socio-economic consequences

- → Tourism
- → Health and well-being, less cold stress in the North
- → Less heating in buildings
- → Increased growth conditions for plants where water is not limiting
- → Loss of valuable goods at the coast and in coastal cities
- → Increasing costs for coastal protection (south) and adaptation
- → Detoriorationg conditions for agriculture and forestry (in the south; adaptation necessary)

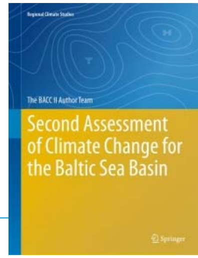
Agriculture and Forestry

Urban complexes

Coastal erosion

BACC 2 Chapter 20-22

Regional Attribution



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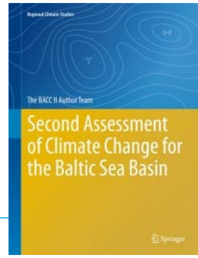
→ Question:
Is it possible to attribute recent regional climate change to human influence and other causes?

Particular focus on the external forcing mechanisms that have been identified to cause recent global warming

- → **Anthropogenic greenhouse gas emissions**
  Emerging anthropogenic signal in seasonal temperature, but evidence too weak for precipitation, wind, etc.
- → **Natural and anthropogenic emissions of aerosols**
  Aerosol emissions over Europe may have an effect on large-scale circulation over Europe and effect on the climate in the Baltic Sea region, but evidence is vague
  Analyses on regional aerosol effects rare and models unable to simulate aerosol–climate interactions
- → **Changes in land use and land cover**
  Can have counteracting effects on climate (biogeochemical vs. biogeophysical effects)
  No indication of land use and land cover effects on recent climate change
  Further understanding and modelling efforts urgently necessary

BACC 2 Chapter 23-25

Summary



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- → Clearly observed increases in temperature (air und water) as well as sea level ; connected changes in freezing and melting dates, ice cover, coastal erosion, vegetation periods, plant growth
- → Uncertainties in precipitation and wind
- → Further warming and sea level rise expected (but land uplift in the North counteracts sea level rise)
- → Anhropogenic climate warming is but one man-made factor for observed environmental changes in the region (e.g. eutrophication, land use and fragmentation, pollution, overfishing)
- → Further research necessary, particularly in the role of land cover and aerosols for the regional climate

Thank you for your attention!

Baltic Earth

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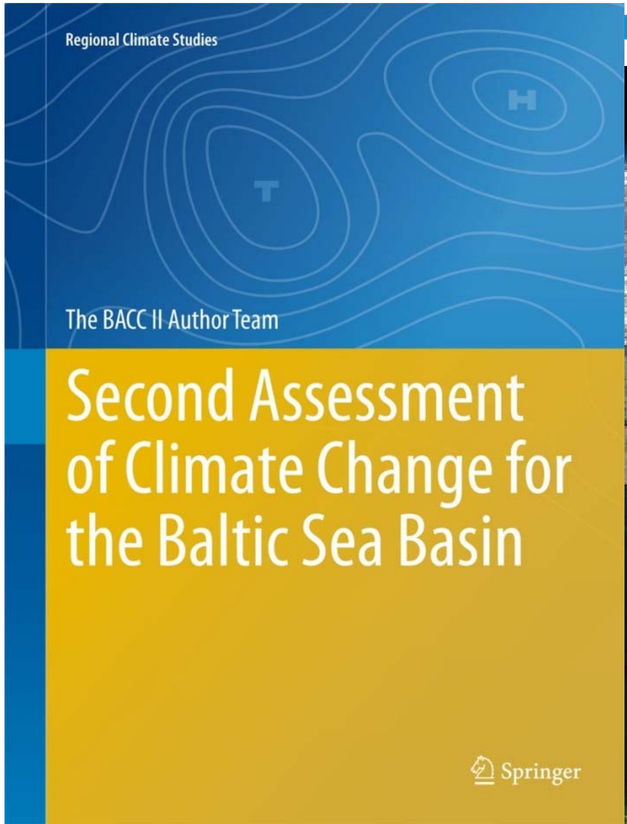

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Today 13:15-13:45 in Auditorium 11

with Podium Discussion