BACC II

Process, and summary of most significant results

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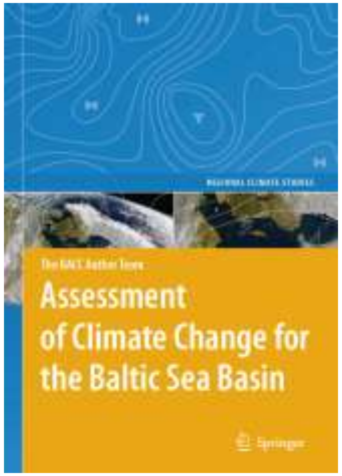
BALTEX Assessment of Climate Change for the Baltic Sea basin - BACC

An effort to establish which scientifically legitimized knowledge about climate change and its impacts is available for the Baltic Sea catchment.

Approximately 80 scientists from 12 countries have documented and assessed the published knowledge in 2008 in BACC.

The assessment has been accepted by the inter-governmental HELCOM commission as a basis for its future deliberations.

Principles



→ The assessment is a synthesis of material drawn comprehensively from the available scientifically legitimate literature (e.g. peer reviewed literature, conference proceedings, reports of scientific institutes).

→ Influence or funding from groups with a political, economical or ideological agenda is not be allowed; however, questions from such groups are welcome.

→ If a consensus view cannot be found in the above defined literature, this is clearly stated and the differing views are documented. The assessment thus encompasses the knowledge about what scientists agree on but also identify cases of disagreement or knowledge gaps.

→ The assessment is evaluated by independent scientific reviewers.

BACC (2008) results – in short

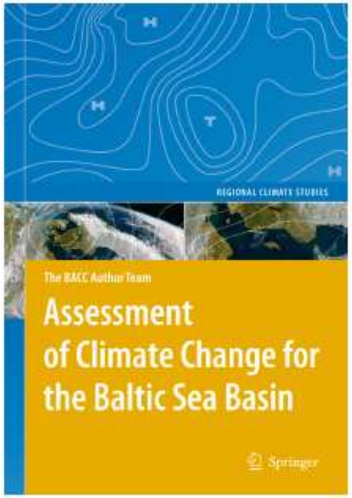
→ Presently a warming is going on in the Baltic Sea region, and will continue throughout the 21st century.

→ BACC considers it plausible that this warming is at least partly related to anthropogenic factors.

→ So far, and in the next few decades, the signal is limited to temperature and directly related variables, such as ice conditions.

→ Later, changes in the water cycle are expected to become obvious.

→ This regional warming will have a variety of effects on terrestrial and marine ecosystems – some predictable such as the changes in the phenology others so far hardly predictable.



Timeline of BACC II

January 2009:	1st BACC II Working Group meeting (Helsinki)
April 2010:	2nd BACC II Working Group meeting (Lund), nomination of BACC II Science Steering Committee (SSC) and suggestions for BACC II Lead Authors
June 2010:	BACC II Lead Authors approved
November 2010:	1st meeting of BACC II Lead Authors and SSC (Göteborg)
March 2011:	2nd meeting of BACC II Lead Authors and SSC (Hamburg)
February 2012:	3rd meeting of BACC II Lead Authors and SSC (Copenhagen)
July 2012:	Chapters ready for external review
September 2012:	BACC II Conference in Tallinn
End 2012:	External peer-review completed
Mid 2013:	Draft BACC II report finished
End 2013/2014:	BACC II book published

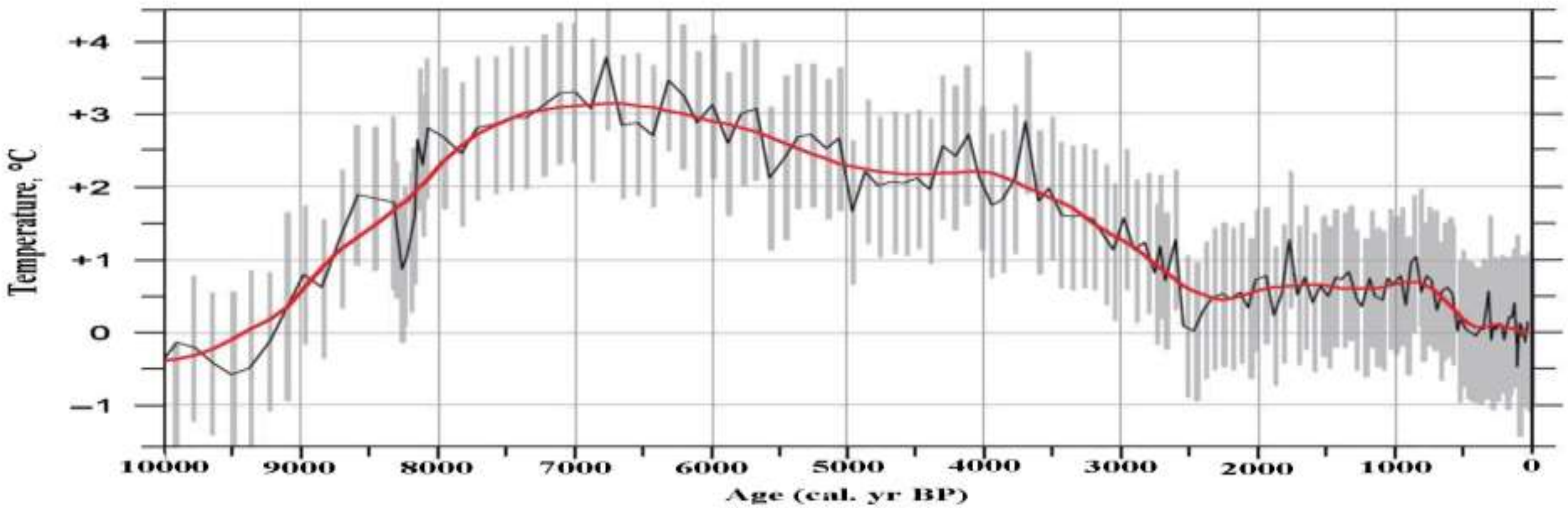
Overall Summary

1. New assessment finds results of BACC I valid
2. Significant detail and additional material has been found and assessed. Some contested issues have been reconciled (e.g. sea surface temperature trends)
3. Ability to run multi-model ensembles seems a major addition; first signs of detection studies, but attribution still weak
4. Regional climate models still suffer from partly severe biases; the effect of certain drivers (aerosols, land use change) on regional climate statistics cannot be described by these models.
5. Homogeneity is still a problem and sometimes not taken seriously enough
6. The issue of multiple drivers on ecosystems and socio-economy is recognized, but more efforts to deal with are needed
7. In many cases, the relative importance of different drivers, not only climate change, needs to be evaluated.

2. Past climate variability

2.2 Holocene (12,000 yr)

Summer temperature anomalies shown as deviations from the modern value. Lake Kurjanovas, south eastern Latvia, 56°31'N (Heikkilä and Seppä 2010).



The Baltic Sea region has seen remarkable changes since the end of last ice age (last 10 – 12,000 years).

The externally forced climate variability in the Baltic Sea basin is most likely attributable to orbital forcing at millennial time scales, to changes in solar irradiance at multi-decadal or centennial timescales, and to volcanic activity at multidecadal timescales. In addition to the external climate drivers factors, non-linear mechanisms in the different components of the climate system and within each subsystem give rise to internal climate variability at all timescales.

Change during the last 200 years

In general, the **conclusions from BACC I** (2008) are confirmed.

→ Important to stress the extremely high inter-annual and inter-decadal variability in most variables

→ Variability is much higher than long-term trends, trends depend very much on the selected period

New results include

→ Persistence of weather types has increased

→ Upwelling analysis

→ Evidence of recent sea water warming (indicated in BACC I, now verified)

→ More extensive results for several parameters, in particularly on sea level

→ Runoff explained by temperature, warming is associated with less runoff in southern regions and more runoff in northern regions

Air temperature

The warming of the low level atmosphere is larger in the Baltic Sea regions than the global mean for the corresponding period.

Warming continued for the last decade
→ Not in winter
→ Largest in spring
→ Largest for northern areas

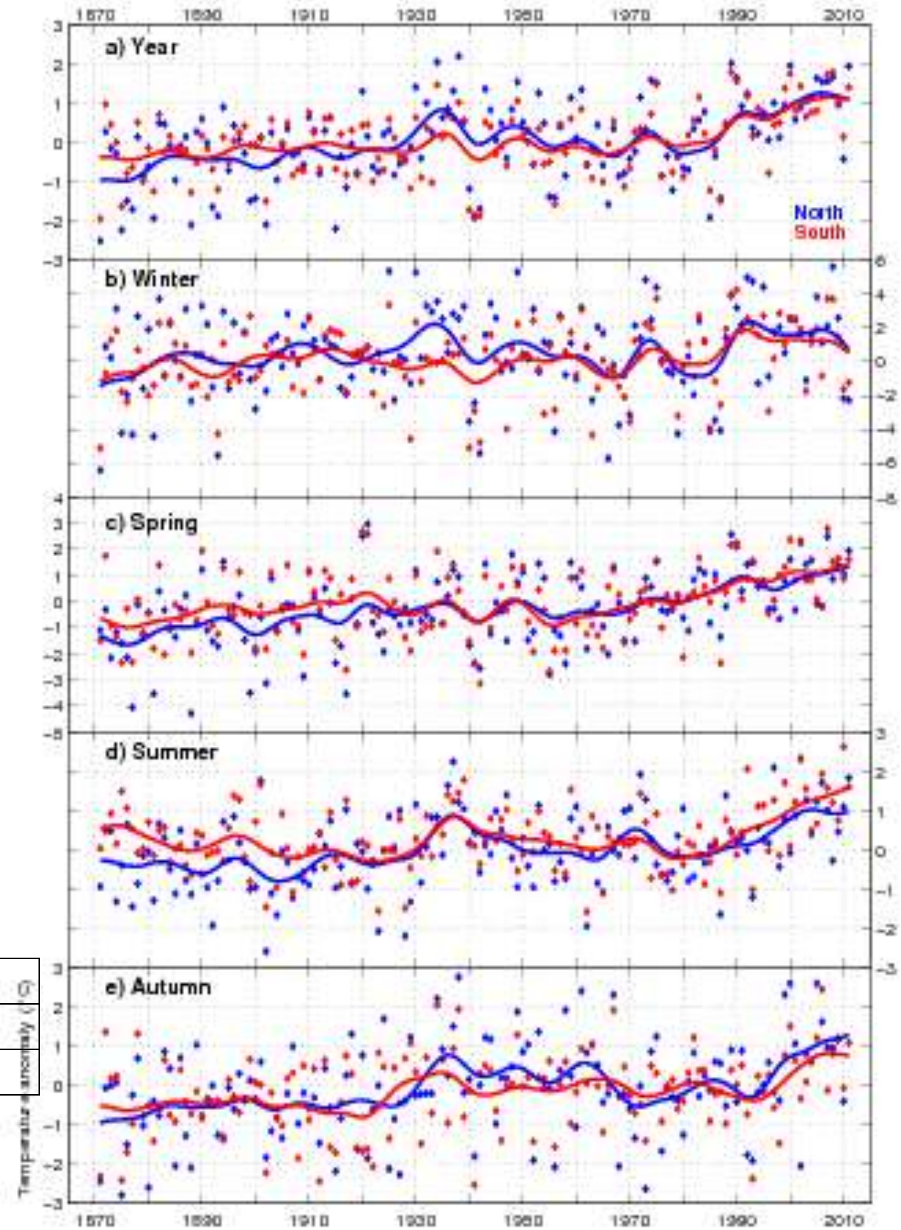
No recent ”stagnation” except for winter.

Data sets	Year	Winter	Spring	Summer	Autumn
Northern area	**0.11**	0.10	**0.15**	**0.08**	**0.10**
Southern area	**0.08**	**0.10**	**0.10**	**0.04**	**0.07**

Linear surface air temperature trends (K per decade) for the period 1871-2011 for the Baltic Sea Basin. Northern area is latitude > 60°N. Bold numbers are significant at the 0.05 level.
Data updated for BACCII from the CRUTEM3v dataset (Brohan et al. 2006)

Same for 1871-2004 (BACC I):

Data sets	Year	Winter	Spring	Summer	Autumn
Northern area	**0.10**	0.09	**0.15**	**0.06**	**0.08**
Southern area	**0.07**	**0.10**	**0.11**	0.03	**0.06**



Annual and seasonal mean surface air temperature anomalies for the Baltic Sea Basin 1871-2011, Blue colour comprises the Baltic Sea basin to the north of 60°N, and red colour to the south of that latitude.

Variable	Long term trend	Last decades
Air temperature	positive	positive
Water temperature	positive	positive
Precipitation	no trend	Mainly positive
Wind	no trend	Mainly positive
Runoff	no trend	positive
Sea level	positive	positive
Ice extent	negative	negative
Snow cover	negative	negative
Heavy precip	x	positive

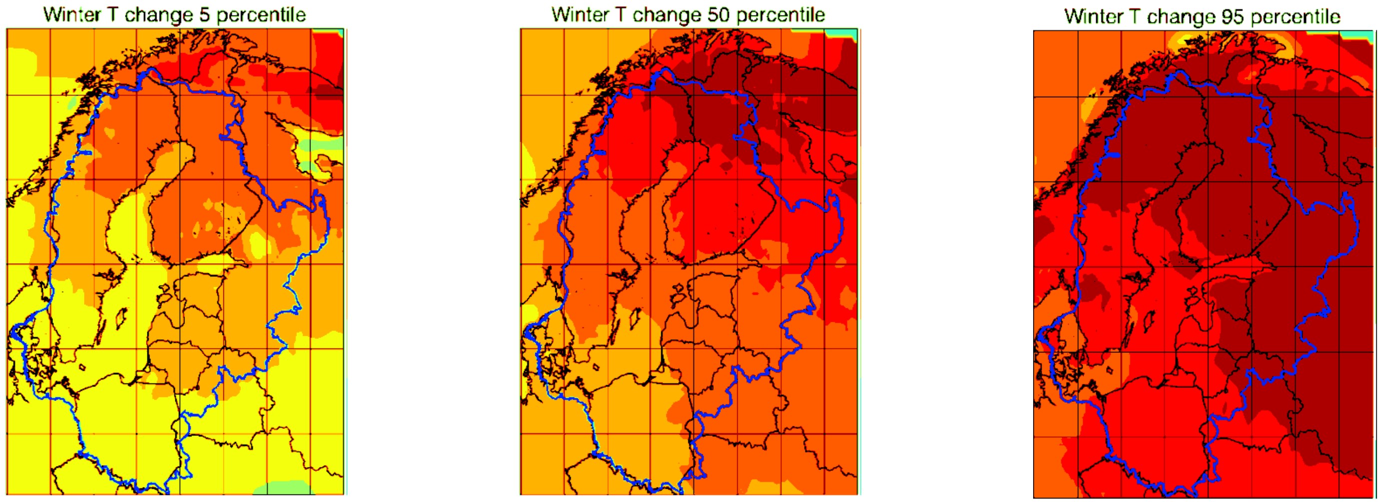
Variable	Long term trend	Short term trend
Clouds	x	Mainly negative
Radiation	x	Positive and negative
Diurnal temperature amplitude	negative	negative
Length of growing season	positive	positive

Regional Climate Models (RCMs) are not yet a perfect tool

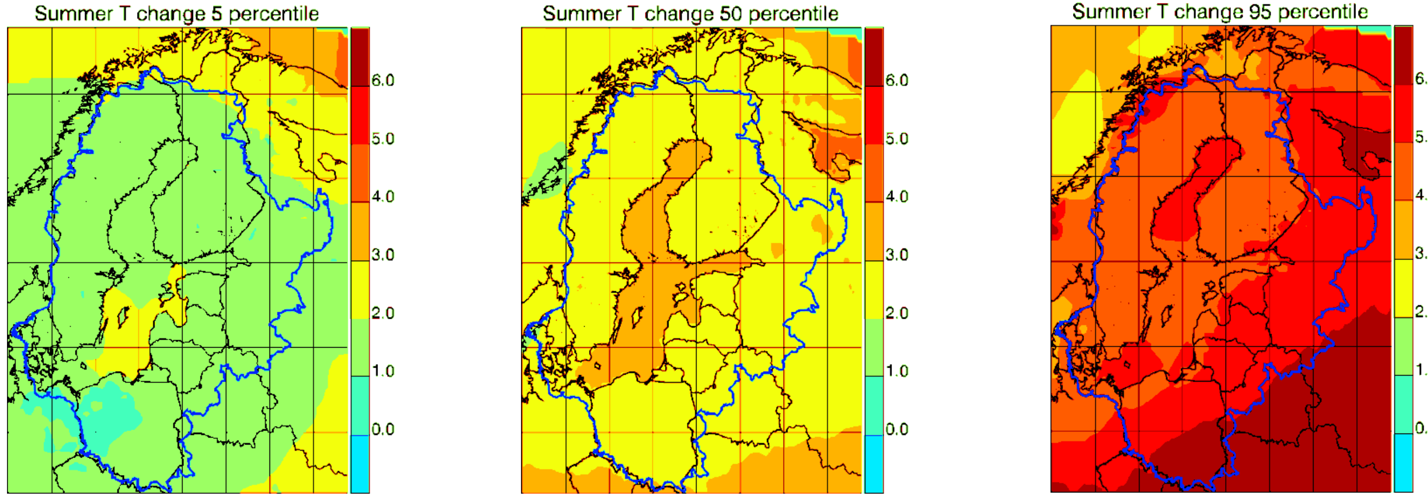
→ Large biases in reproducing observed climate, in particular with the energy and water cycle, both amounts, but also extremes

→ Inability to deal with other drivers, in particular aerosol loads and changing land surface conditions

→ Disregard of dynamic coupling of Baltic Sea, regional atmosphere and other compartments

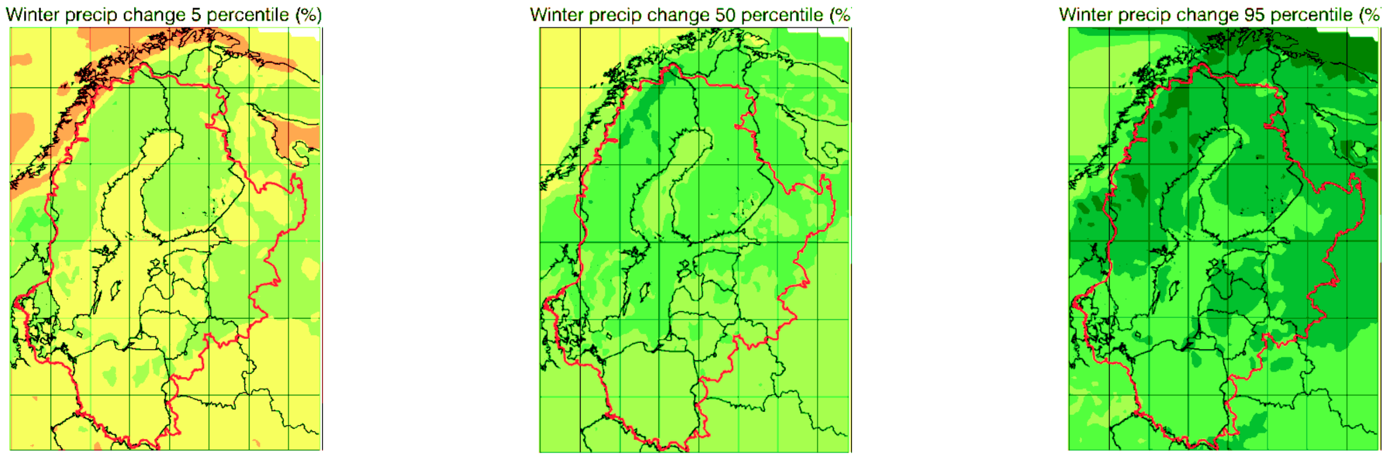


Range of projected change of: Temperature – at the end of the century

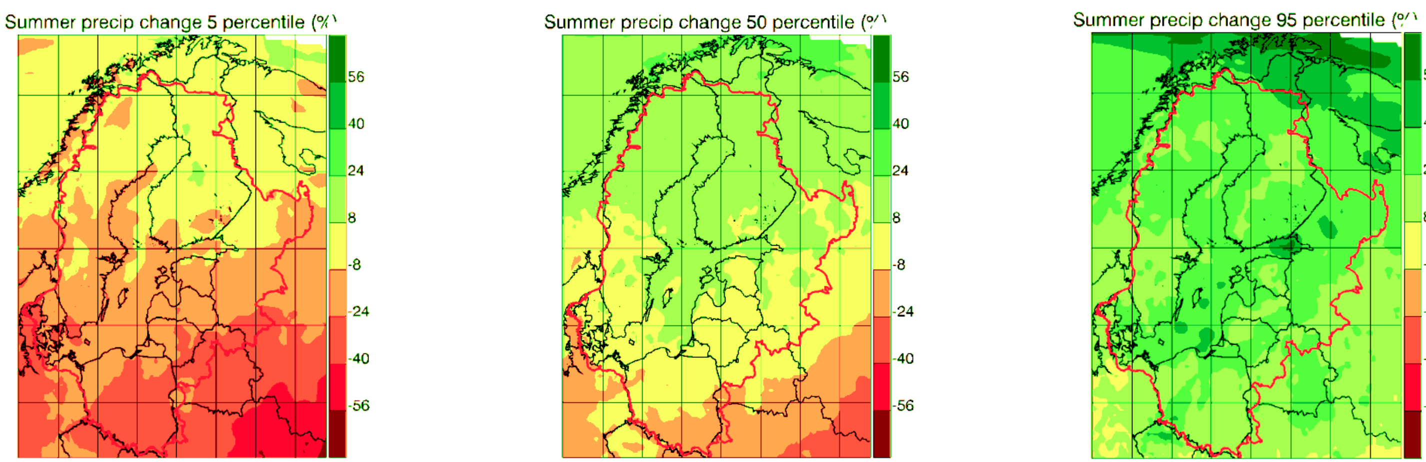


Assessment of Climate Change for the Baltic Sea Basin: BACC II

7th Study Conference, on BALTEX, Borgholm, Sweden, 10 June 2013



Range of projected change of: precipitation amount – at the end of the century



Environmental Impacts

→ The main changes in **air pollution** in the Baltic Sea region are due to changes in emissions rather than climate-change itself

→ More **riverine disolved organic matter**, effects of climate on cultivated watersheds unknown, both positive and negative feedbacks on nutrient fluxes, agricultural practices will adopt fast.

→ Terrestrial **ecosystems near the coast** most prone to climate change; significant increase in spruce growth in the North

→ Higher turnover of **algal biomass** may lead to larger anoxic areas; pH will decrease

→ **Regimes shifts** in the Baltic Sea ecosystem have been observed which may be related to climate variability;

→ **Lower salinity** may lead to less marine benthic species, unknown for pelagic groups (more nutrients and DOM may result in opposite effects)

→ **Few evidence for impacts of climate change as such**

→ **Agriculture and forestry**:
Climate change affects directly **vulnerability and productivity** of agricultural and forestry systems
Predominantly by changes in **precipitation and temperature patterns**.
Indirect impacts are altered risks for damage, such as **increased stress periods** (droughts

→ **Urban complexes**:
Impacts differ due to location of urban complexes, be they in the northern or southern part of the catchment, directly at the Baltic Sea coast or more inland. **Every urban complex is a unique mixture** of infrastructure and urban services, inhabitants, natural resources and green spaces, built structures, economic and societal factors - hardly possible to generalize potential extent of climate change impacts from single-case studies.
Urban complexes are subject to **other change processes** as well (demographic, economic, social, political, technological, land-use) which might interact with climate change impacts

→ **Coastal erosion and coastline changes**: Many natural and human influences on coasts – difficult to identify specific climate change impacts. **Key climatic factor for coastal development: wind driven factors.** Seasonal climate change (high water level, storm events, ice periods, heavy rain) can cause erosion, landslides, flooding

Detection and Attribution

→ Detection of non-natural influence on regional **warming.** Can be explained only by increased greenhouse gas concentrations. Present trend consistent with model scenarios.

→ Detection of non-natural component in trends of **precipitation amounts**; present trends much larger than what is anticipated by models; thus no consistent explanation for the time being.

→ Lack of studies on detection of changes in other variables (e.g. snow cover, runoff, sea ice)

→ Lack of studies of the effect of other drivers (reduction of industrial aerosols, land use change)

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