



# Sea Level Change

## What do we know about sea-level change in the Baltic Sea?

Overview of knowledge about sea-level variability and change in the Baltic Sea region

Birgit Hünicke and Hans von Storch

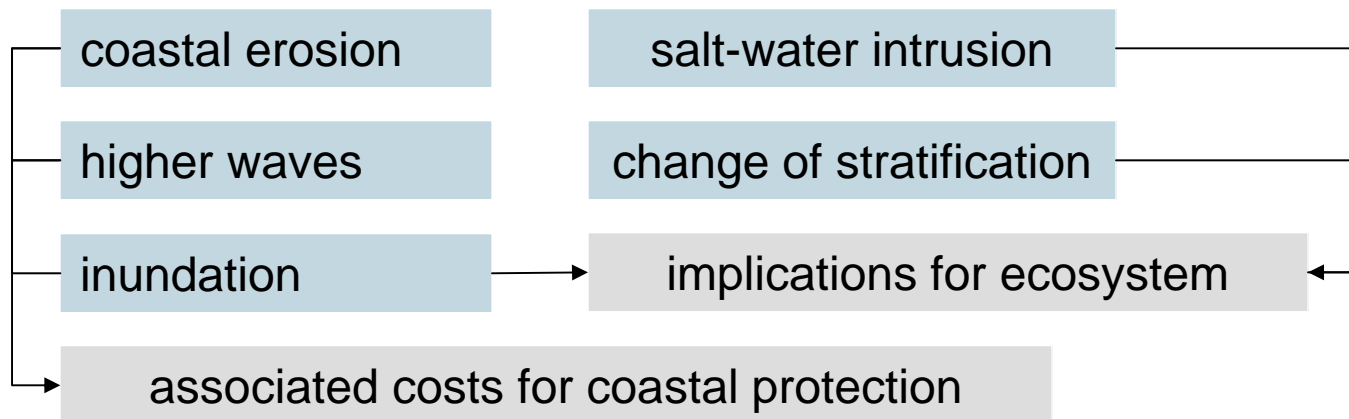
# Purpose



- issue of increasing importance, especially in the context of anthropogenic global climate change

→ one of the key topics of IPCC AR4 (2007)

- possible impacts of sea-level rise:



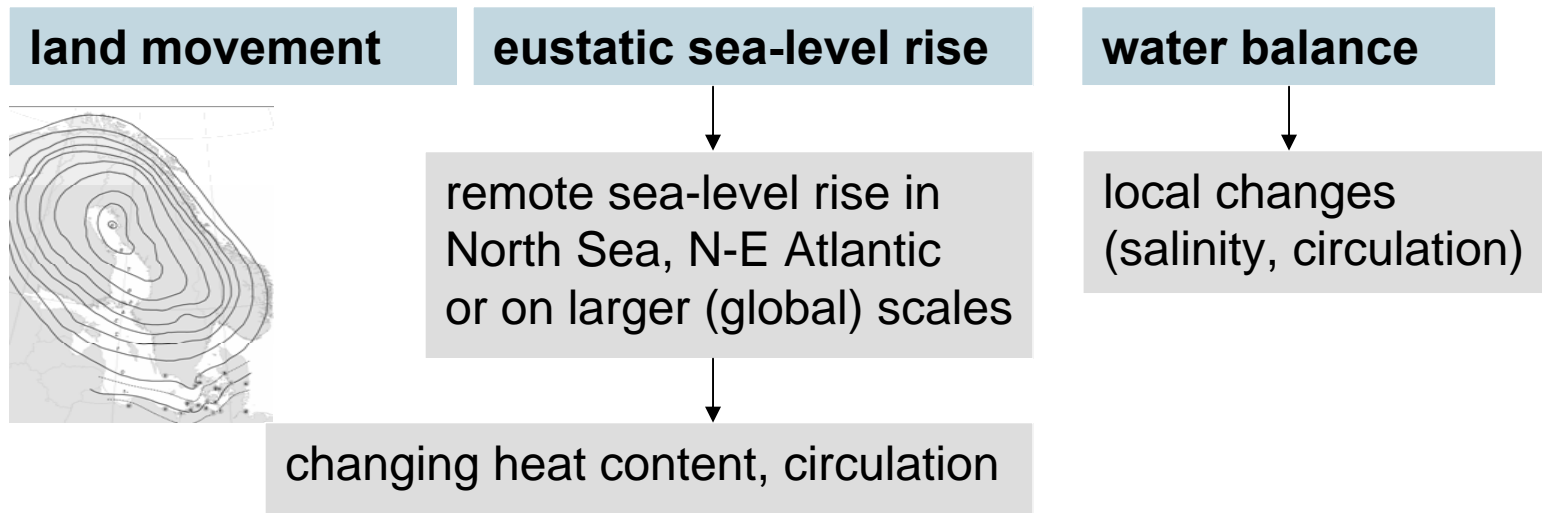
→ from our recent experience from communicating with regional stakeholders it has become very clear that this issue must be considered a major issue for stakeholders and the public at large.

# Particular Aspects

- global average of sea-level ensconces strong regional variations

→ may be caused by regional to local scale processes

- main factors affecting long-term Baltic Sea level:

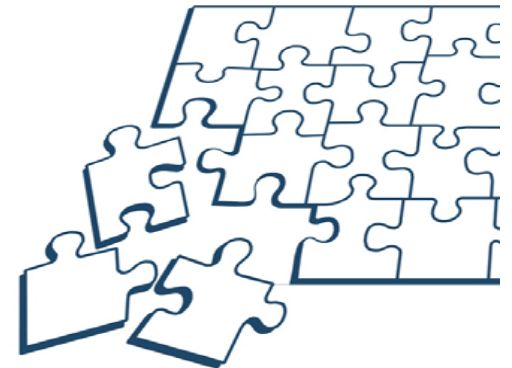


→ key issues of the overview of knowledge about Sea level Change in the Baltic

# Particular Aspects

for example ...

- Are satellite-altimeter observations already useful for the study of Baltic Sea level variability?
- Are there new efforts made in the development of advanced geodetic techniques for measuring vertical land movement at tide gauges?
- Which available input data are used up to date by coastal engineers for hydrodynamic or sediment transport models?
- Which sea-level data are available for the Baltic Sea research community, and which of the data have been quality controlled by peer-reviewed scientific studies?
- Which climatic data were used so far for studying the climatic influence on sea level in the Baltic Sea? Has full advantage been made of existing data?
- Is there a need for more cross-national studies?
- What are the challenges for future Baltic Sea level research?
- What is known? What is very likely? And what is still uncertain?



# Approach

- **literature research**

(internet, libraries, requests, personal communications to authors etc)

- 'sea-level change' in BACC  
until 2005/6

- What is included?
- What is missing ?

- 'sea-level change' in BONUS  
publication report 2002-2006

- Comparison to BACC

- 'sea-level change' after BACC  
2006 -2009

→ **∑ 143 publications** (preliminary Nov 09)

# Approach

## ▪ literature research

(internet, libraries, requests, personal communications to authors etc)

## ▪ 'sea-level change' in BACC until 2005/6

- What is included?
- What is missing ?

## ▪ 'sea-level change' in BONUS publication report 2002-2006

- Comparison to BACC

## ▪ 'sea-level change' after BACC 2006 -2009

- ask Baltex Research Community for help via Baltex Newsletter (October 2009, No.13)



## What is known about sea-level change in the Baltic Sea?

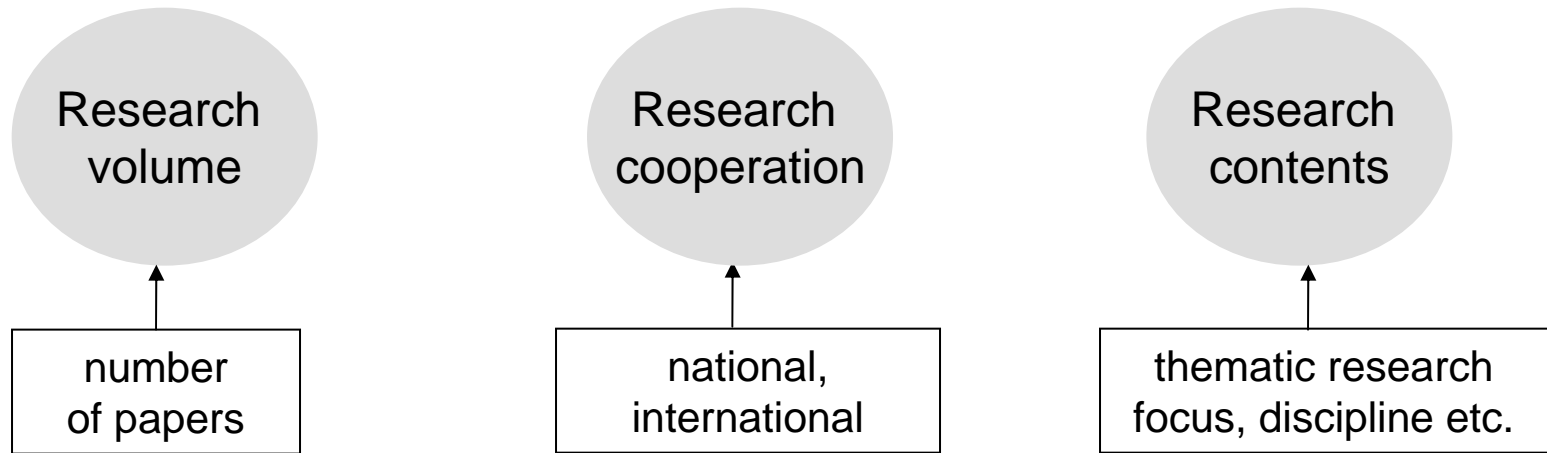
*Birgit Hünicke (birgit.huenicke@gkss.de) and Hans von Storch (hvonstorch@web.de), Institute for Coastal Research, GKSS Research Centre Geesthacht, Germany*

In this respect, we kindly ask the BALTEX research community for help. Please inform us about publications in any language, ongoing projects and initiatives dealing with sea-level variations and change in the Baltic Sea, including coastal erosion. Helpful suggestions, comments, details and references concerning planned or ongoing research related to Baltic Sea level studies are most welcome.

→ **∑ 143 publications** (preliminary Nov 09)

# Approach

- evaluation of different aspects/ criterias (following BONUS approach)



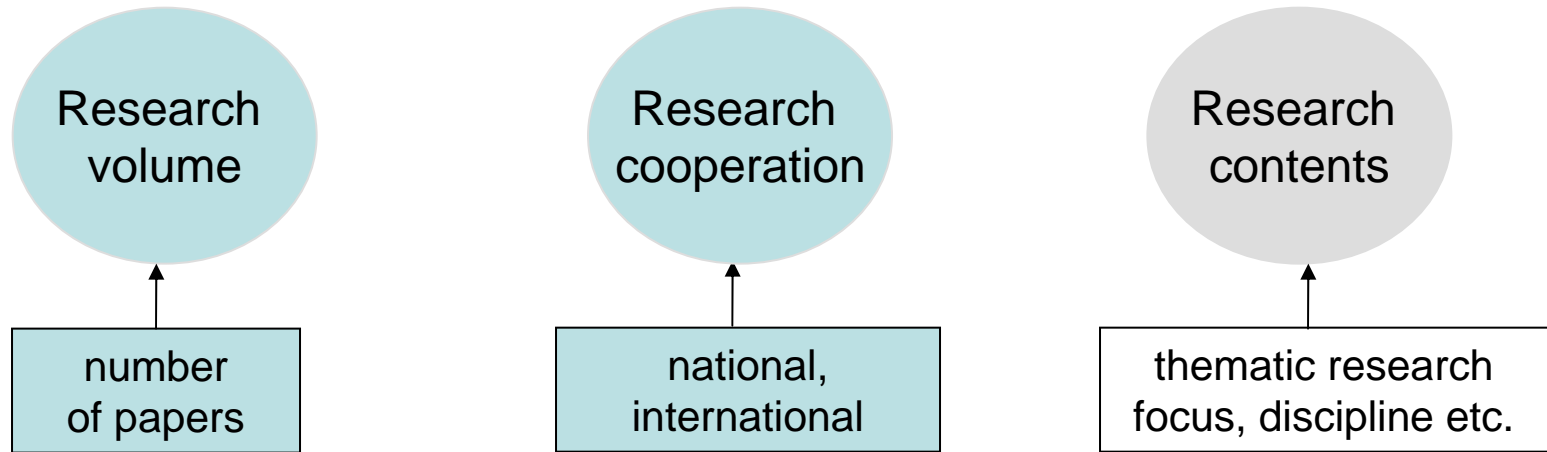
- peer-reviewed?

- cross-national studies?



# Approach

- evaluation of different aspects/ criterias (following BONUS approach)



- peer-reviewed?
- cross-national studies?

- in BACC (until 05/06) / not in BACC (until 05/ 06) / after BACC (06-09)





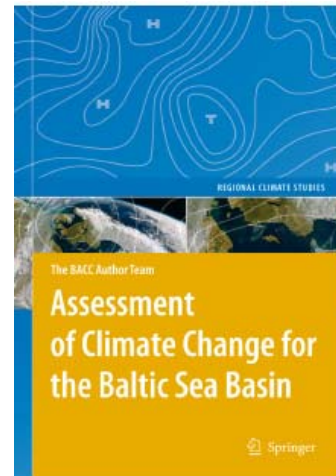
# Sea level in BACC

<b>2</b>	<b>Past and Current Climate Change</b>	<b>35</b>
2.3	The Baltic Sea	87
2.3.1	Hydrographic Characteristics	87
2.3.1.1	Temperature	88
2.3.1.2	Salinity and Saltwater Inflows	93
<b>2.3.2</b>	<b>Sea Level</b>	<b>96</b>
2.3.2.1	Main Factors Affecting the Mean Sea Level	96
2.3.2.2	Changes in the Sea-level from the 1800s to Today	97
2.3.2.3	Influence of Atmospheric Circulation	99
2.3.3	Sea Ice	99
2.3.3.1	Ice Extent	100
2.3.3.2	Length of the Ice Season	101
2.3.3.3	Ice Thickness	102
2.3.3.4	Large-scale Atmospheric Forcing on the Ice Conditions	102
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2.3.4	Coastal Erosion	105
2.3.4.1	Western Part of the South Baltic Sea Coast	105
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2.3.5	Wind Waves	108
2.4	Summary of Observed Climate Changes	110
2.5	References	112
<b>3</b>	<b>Projections of Future Anthropogenic Climate Change</b>	<b>133</b>
3.1	Introduction to Future Anthropogenic Climate Change Projections	133
3.2	Global Anthropogenic Climate Change	133
3.2.1	Global Warming in the 21 <sup>st</sup> Century	134
3.2.2	Geographical Distribution of Anthropogenic Climate Changes	138
3.2.3	Global Sea Level Rise	139
3.2.4	Global Warming and Sea Level Rise After the Year 2100	139
3.8	Projections of Future Changes in the Baltic Sea	194
3.8.1	Oceanographic Models and Anthropogenic Climate Change	194
3.8.2	Projected Changes in Sea Ice	194
3.8.3	Projected Changes in Sea Surface Temperature and Surface Heat Fluxes	195
3.8.4	Projected Changes in Sea Level and Wind Waves	196
3.8.5	Projected Changes in Salinity and Vertical Overturning Circulation	198
3.9	Future Development in Projecting Anthropogenic Climate Changes	201

Sea level references (until 05/06) included in BACC (2008):

→ 4 pages

→ 40 References



→ 1 pages

→ 14 References

→ 2 pages

(3 already included in 2.3.2)

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**Σ 49 References**

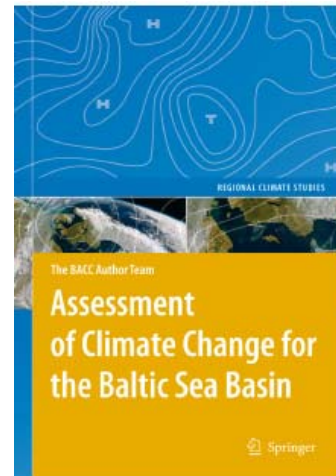
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→ 40 References



BACC Report:

5 main chapters  
~370 pages  
+Annex

→ Sea level  
NOT included in  
overall summary

→ 1 pages

→ 14 References

→ 2 pages

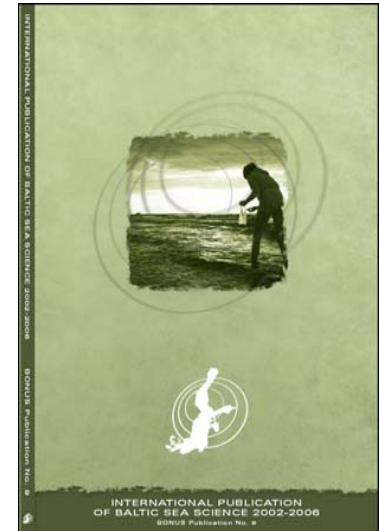
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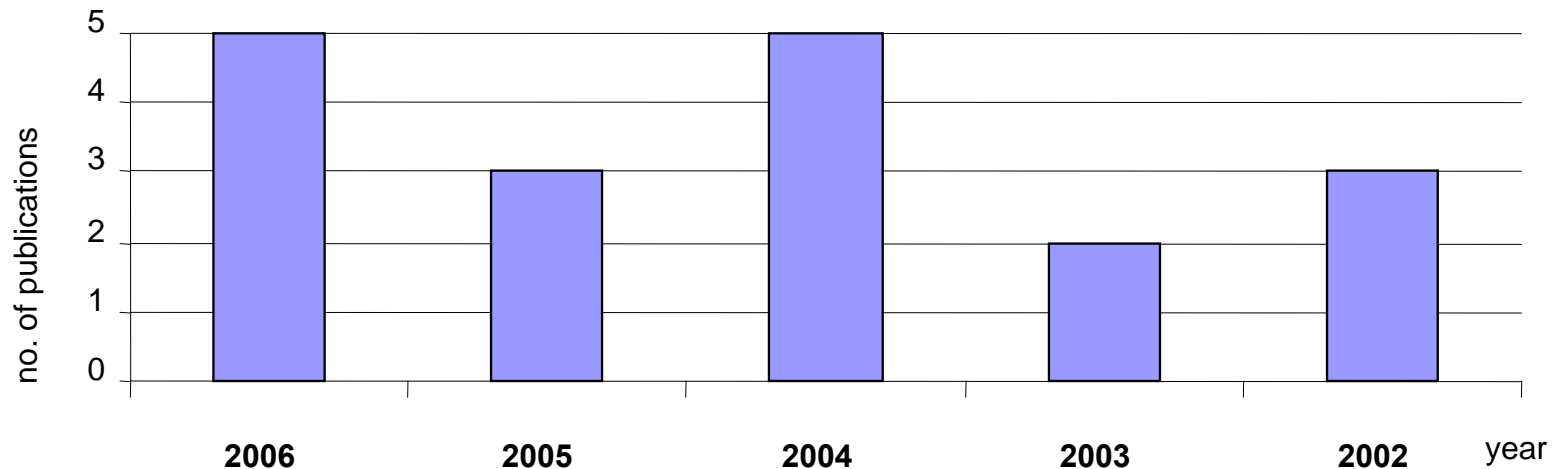
**Σ 49 References**

# Sea level in BONUS

- BONUS analysed scientific output from Baltic Sea research during 2002-2006 (based on a total of 1,975 papers in ISI-ranked journals taken from 15 databases)
- 18 references related to sea-level change in the Baltic (excluding findings from paleo-research)
- there of 9 references in BACC



**Total Publications per Year 2002-2006 (peer-reviewed)**

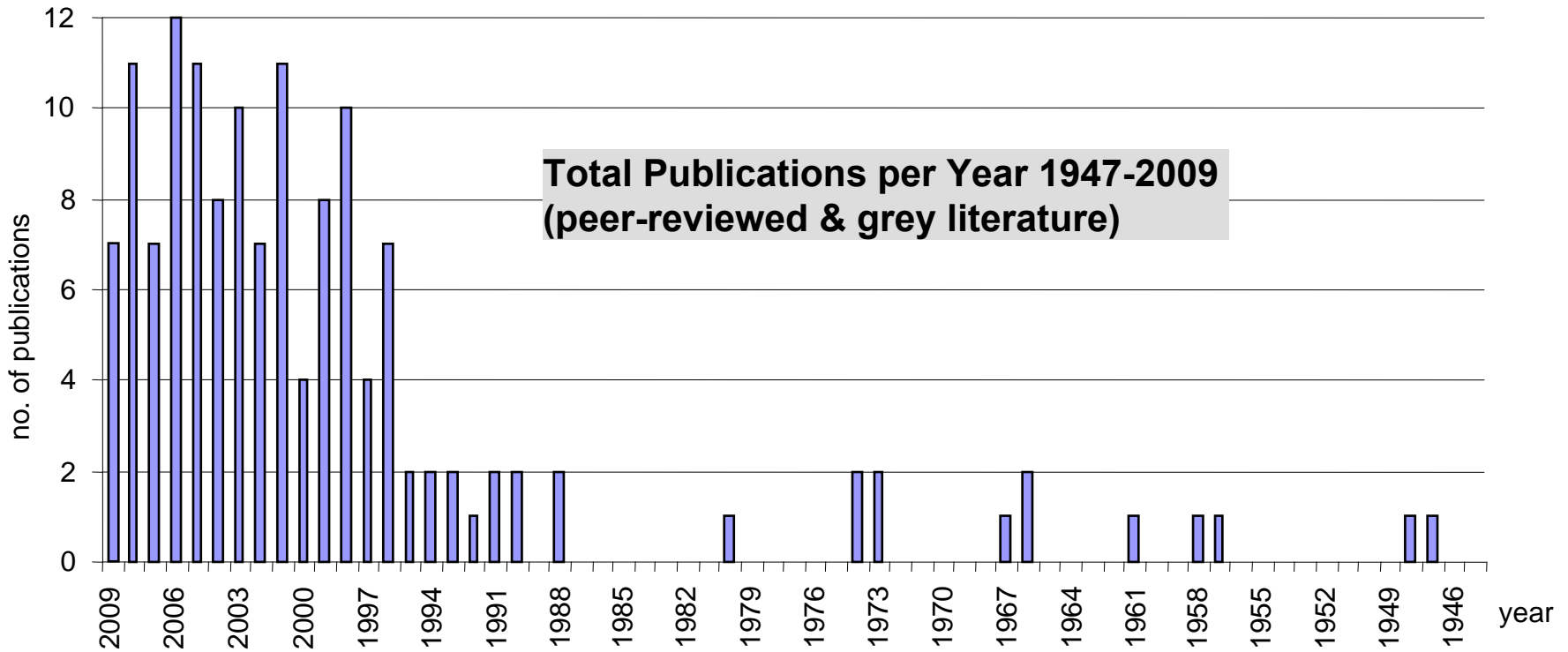


# Review of relevant literature



- **literature research** (internet, libraries, requests, personal communications to authors etc)

→ **∑ 143 publications** (preliminary Nov 09)



# Review of relevant literature



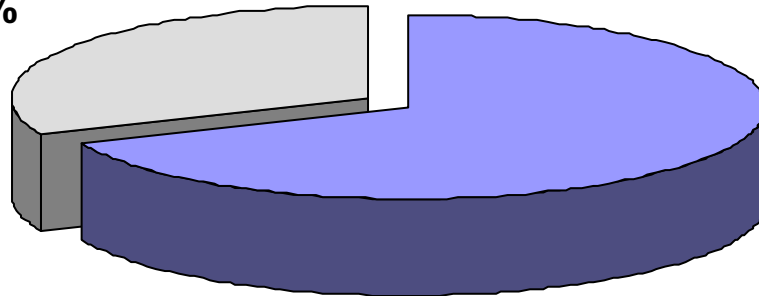
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→  $\Sigma$  **143 publications** (preliminary Nov 09)

- peer-reviewed?

Publications 1947-2009 (total; percent)

45; 32%



97; 68%

- peer-reviewed
- non peer-reviewed

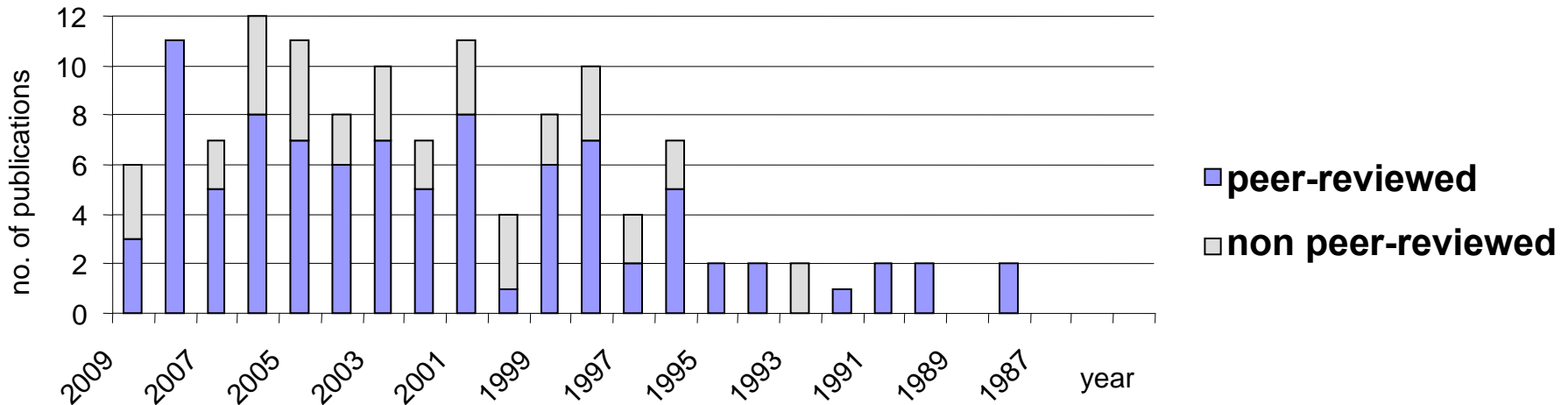
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**Total Publications per Year 1987-2009**



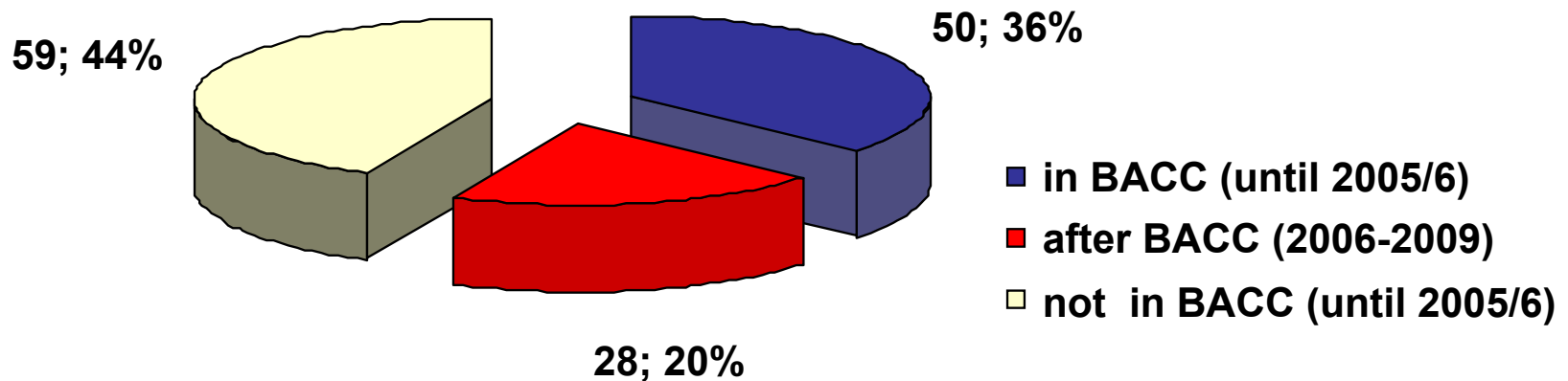
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## Publication Overview (total; percent)

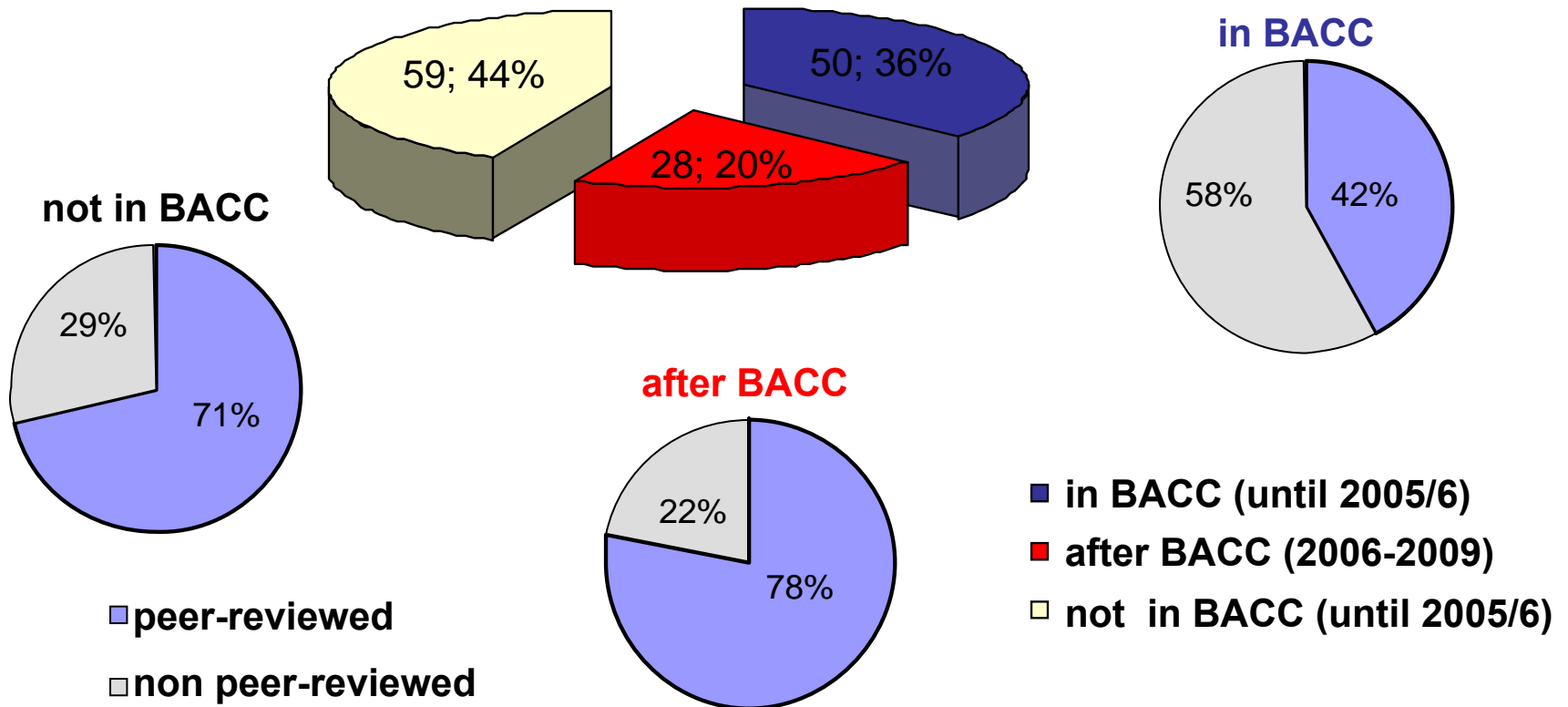


# Review of relevant literature

→  $\Sigma$  143 publications (preliminary Nov 09)



Publication Overview (total; percent)





# Review of relevant literature

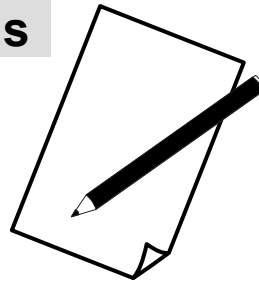
Environmental research, engineering and management  
 J Sea Res  
 Journal of Coastal Conversation  
 Ocean Dyn  
 Reports of the Finish Geodetic Institute  
 Baltica  
 Continent Shelf Res  
 Global Planet Change  
 Int J Climatol.  
 Int J of Earth Science  
 Quaternary Int  
 Die Küste  
 J Coastal Res  
 Mar Geodes  
**Clim Res**  
**GRL**  
**Boreal Env Res**  
**Geophysica**  
**J Geophys Res**  
**Oceanologia**  
**Small Publ Hist Geophys**  
**Tellus A**

Finnish Marine Research  
 Environmental Geosciences  
 Coastal Eng J  
 Clim Dynam  
 Clim Change  
 Boreas  
 Applied Ocean Research  
 Advances in Atmospheric Science

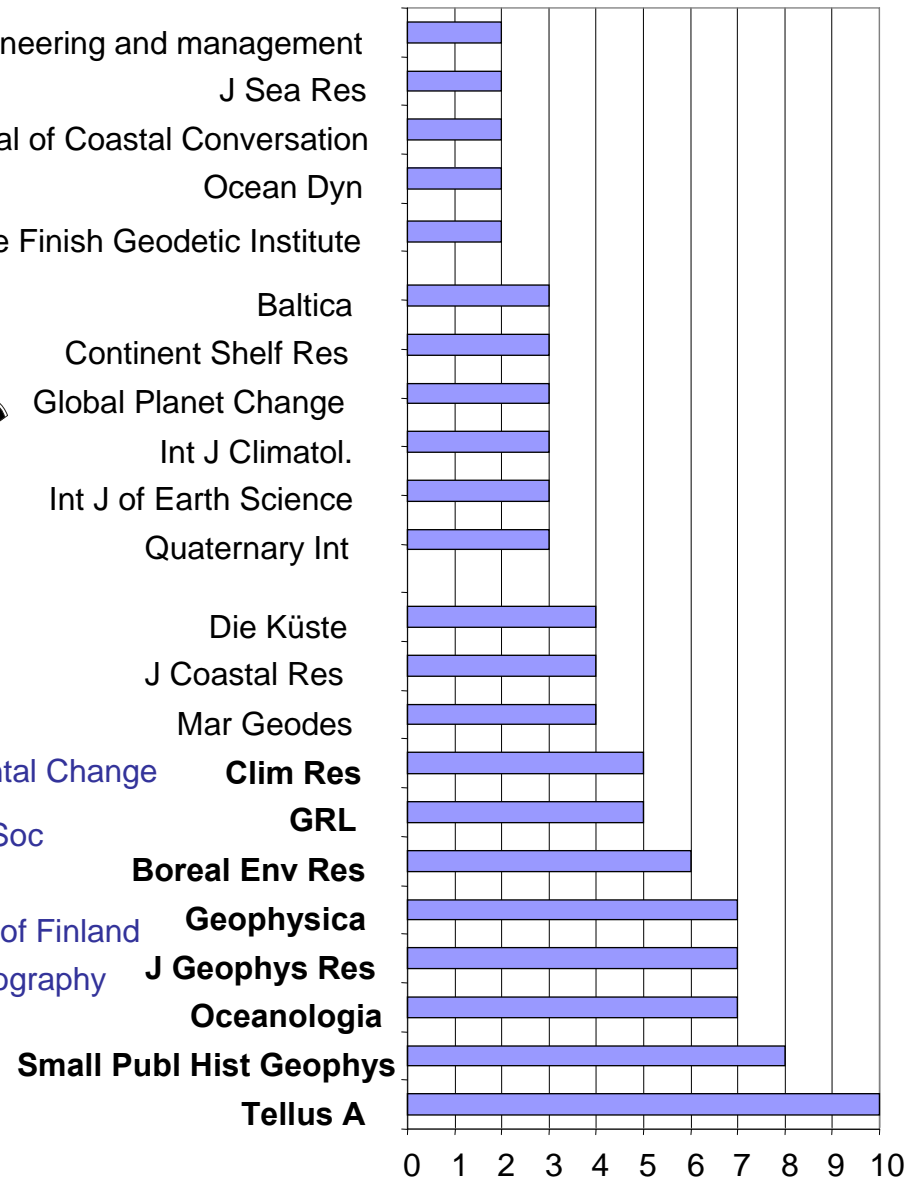
Science  
 Quaternary Science Rev  
 Pure Appl Geophys  
 Palaeogeography,  
 Palaeoclimatology, Palaeoecology

Nordic Hydrology  
 Nature Geoscience  
 Journal of Physical Oceanography  
 Journal of Climate

**45 Journals**

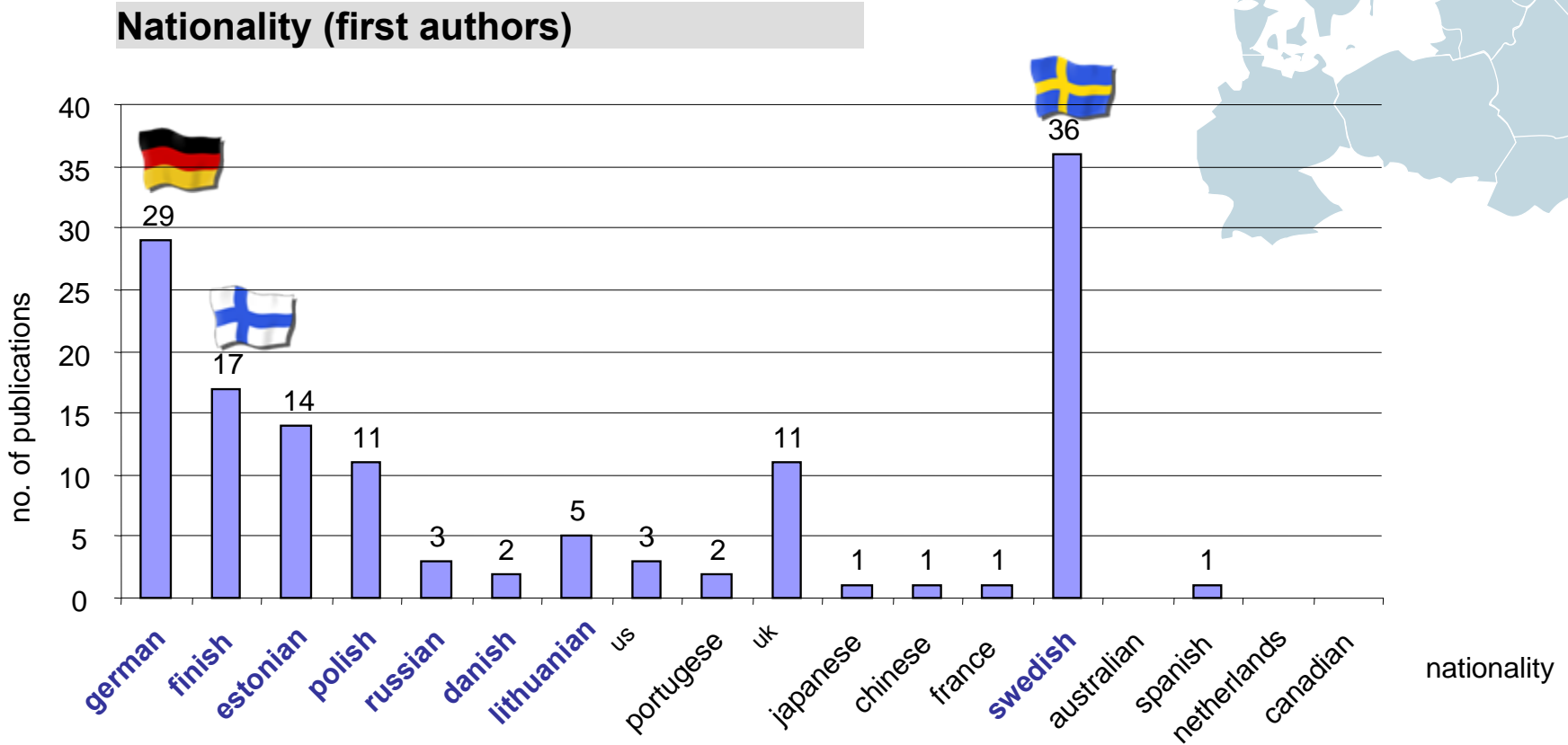


## Journals



# Review of relevant literature

→  $\Sigma$  143 publications (preliminary Nov 09)



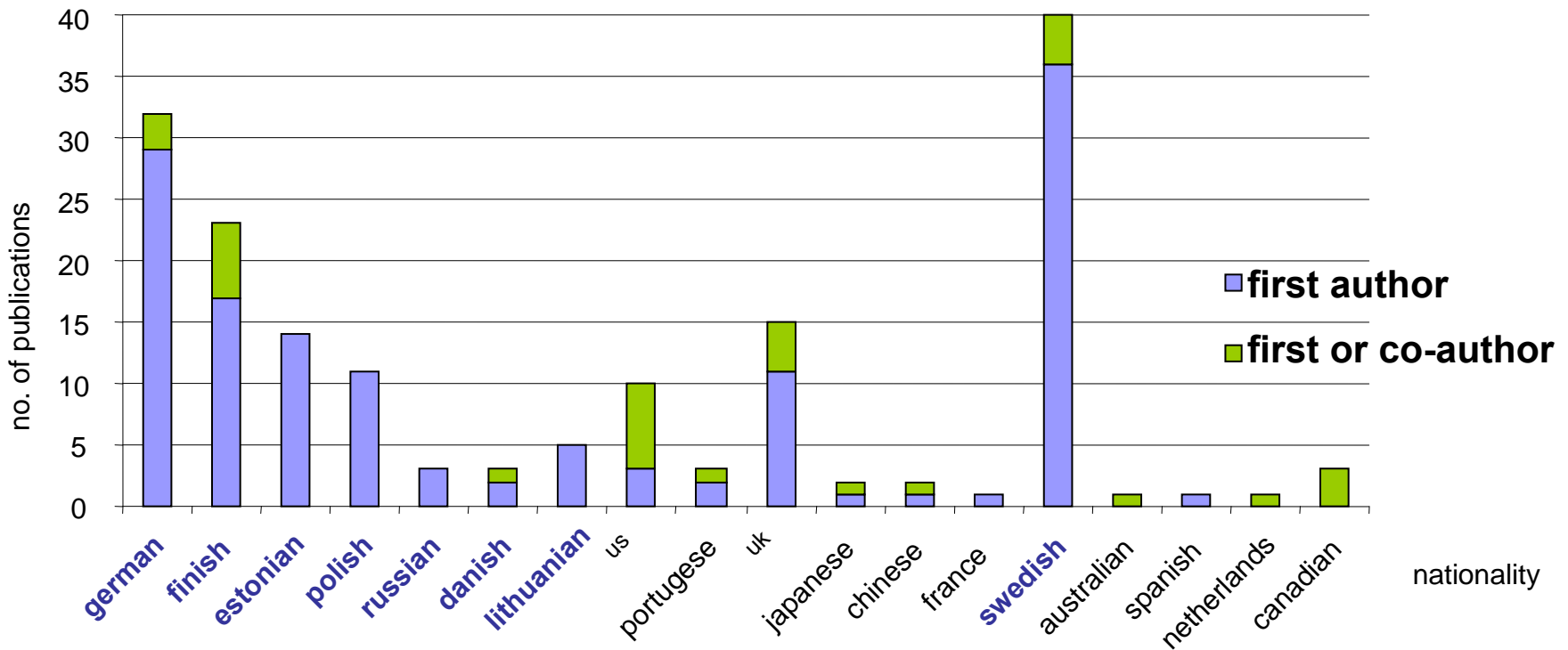
# Review of relevant literature



→  $\Sigma$  143 publications (preliminary Nov 09)

▪ cross-national studies?

## Nationality (first or co-authors)

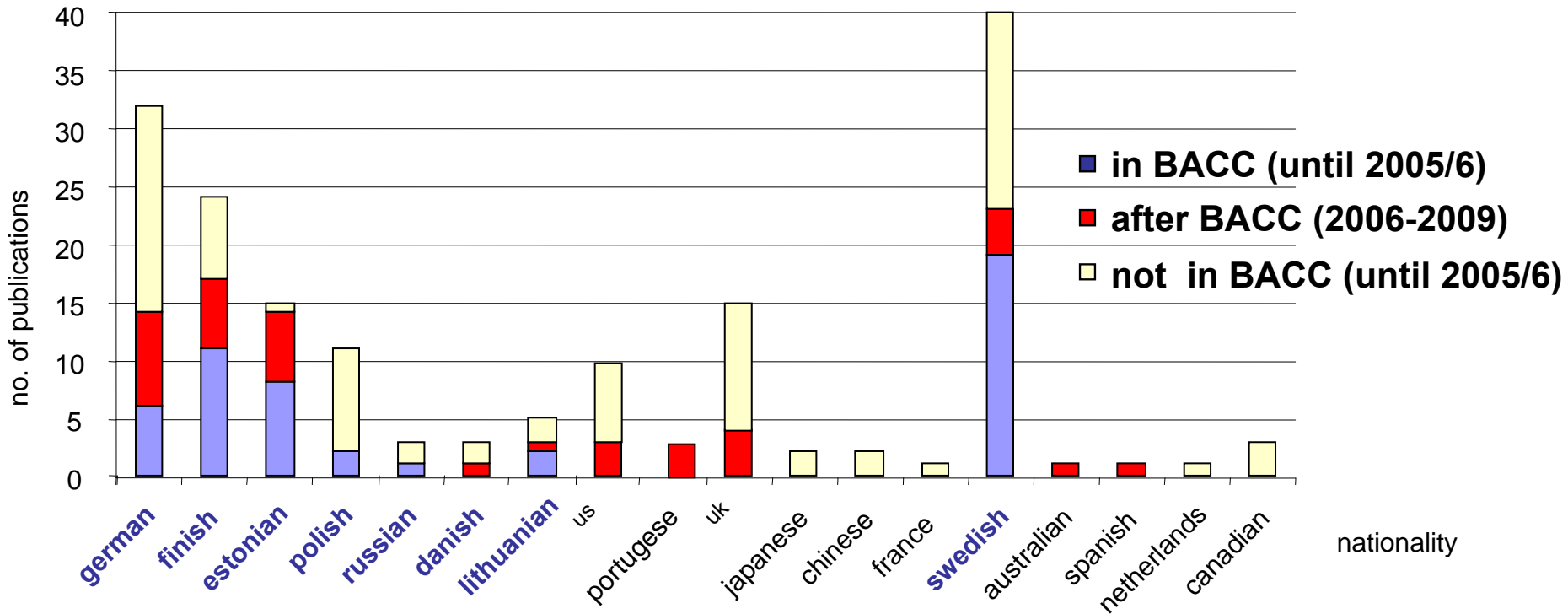


# Review of relevant literature

→  $\Sigma$  143 publications (preliminary Nov 09)



## Nationality (first or co-authors)



# What comes next?



- **literature research** (due to internet, libraries, requests, personal communications to authors etc)

→  $\Sigma$  **143 publications** (preliminary Nov 09)

→ final result of literature research will be implemented in **BALTEX Publication Library**, detectable via keyword 'sea level'

- overview report, summarizing the available knowledge about sea-level variability and change in the Baltic Sea region (until winter 2010)
- possibly → implementation of detected sea level change related questions in the SURBACC survey (collaboration with D. Bray)



The issue of sea level in the Baltic Sea appears relatively less represented in the BACC report (2008) compared to other aspects of climate change, as it is not included in the overall summary.



## Sea Level in BACC

Sea level is a sub-sections of the BACC I 'Baltic Sea Section'

It is planned to be 'upgraded' in BACC II to stay as a separate section parallel on the 'Baltic Sea Section'.

More visible representing of the relevance, also for society.



- **Questions, comments and/or suggestions can be directed to:**

[birgit.huenicke@gkss.de](mailto:birgit.huenicke@gkss.de)

- **Check new issue of the BALTEX Newsletter (No.13) for more details:**

<http://www.baltex-research.eu/publications/newsletter.html>

