balt adapt

Baltic Sea Region
Climate Change Adaptation Strategy

Climate Change in the Baltic Sea Region: Salinity

BALTADAPT CLIMATE INFO # 6

Baltic Sea salinity

The Baltic Sea is characterized by large salinity variations. The water is strongly stratified with a permanent halocline (layer where the salinity changes rapidly with depth). The more saline deep-water in the Baltic Proper enters through the Belts and the Sound. The surface salinity is very low in the Gulf of Bothnia and the Gulf of Finland, due to large river run-off, and increases gradually towards the south and the entrance region. A change in the salinity will influence the occurrence and distribution of various species in the Baltic Sea.

Current situation

The volume averaged salinity in the Baltic Sea shows decadal variations but no long-term trend has been found for the 20th century (BACC, 2008). Estimates of the volume averaged salinity for this period has been reported to 7.4 (based on modelling, Kauker and Meier [2003]) and 7.7 (based on observations, Winsor et al. [2001]). The frequency and magnitude of major deep-water inflows from the North Sea have decreased since the mid-1970s causing periods of stagnation in the bottom water of the Baltic Proper. Variations in the surface salinity are to a large extent coupled to variations in the freshwater input.

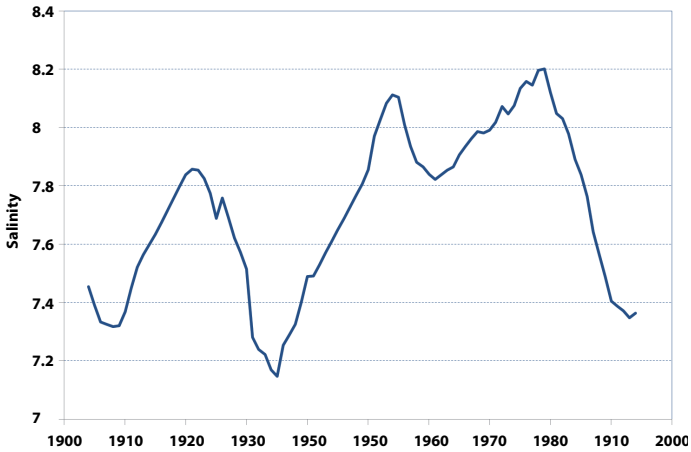

Figure 1: *Volume averaged salinity in the Baltic Sea during the 20th century (redrawn from Hjalmarsson et. al, 2008)*

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Climate change impacts

The results from four different scenario simulations of surface and bottom salinity changes between the periods 2070–2099 and 1969–1998 are presented in a set of maps. The seasonal and annual means of the simulations have been calculated as well as the difference between the maximum and minimum values obtained among them. This latter quantity, the range, is a measure of the spread of the results from the four simulations where a large value indicates a larger uncertainty. (Note that other climate scenarios, and other models, may give different results.) More information about the scenario simulations is given on the back of this bulletin.

› The four simulations all show a decrease in the Baltic Sea volume averaged salinity with a value at the end of the 21st century ranging between 5 and 7.

› The mean change in annual surface salinity is displayed in the left panel in Figure 2. The map shows that, according to the simulations, the surface salinity may decrease over the entire Baltic Sea. The largest decrease is found in the Baltic Proper and the south-eastern part of the Bothnian Sea while the innermost parts of the Bothnian Bay, the Gulf of Finland and the north-western part of Kattegat, are less affected. The seasonal variations are relatively small.

› The largest discrepancies between the four simulations, as depicted in the right panel in Figure 2, are found in the Kattegat. Some slight differences are also found in the East Gotland Sea and in the Gulf of Finland (especially in the southern part) but otherwise the projections generally agree. The differences are largest for the summer and fall season.

› The main reason for the modelled decrease in surface salinity is an increase in the simulated river runoff.

› A corresponding decrease in the bottom salinity is shown in Figure 3 where, again, the left panel pertain to mean changes in the annual salinity. The largest changes are obtained in the

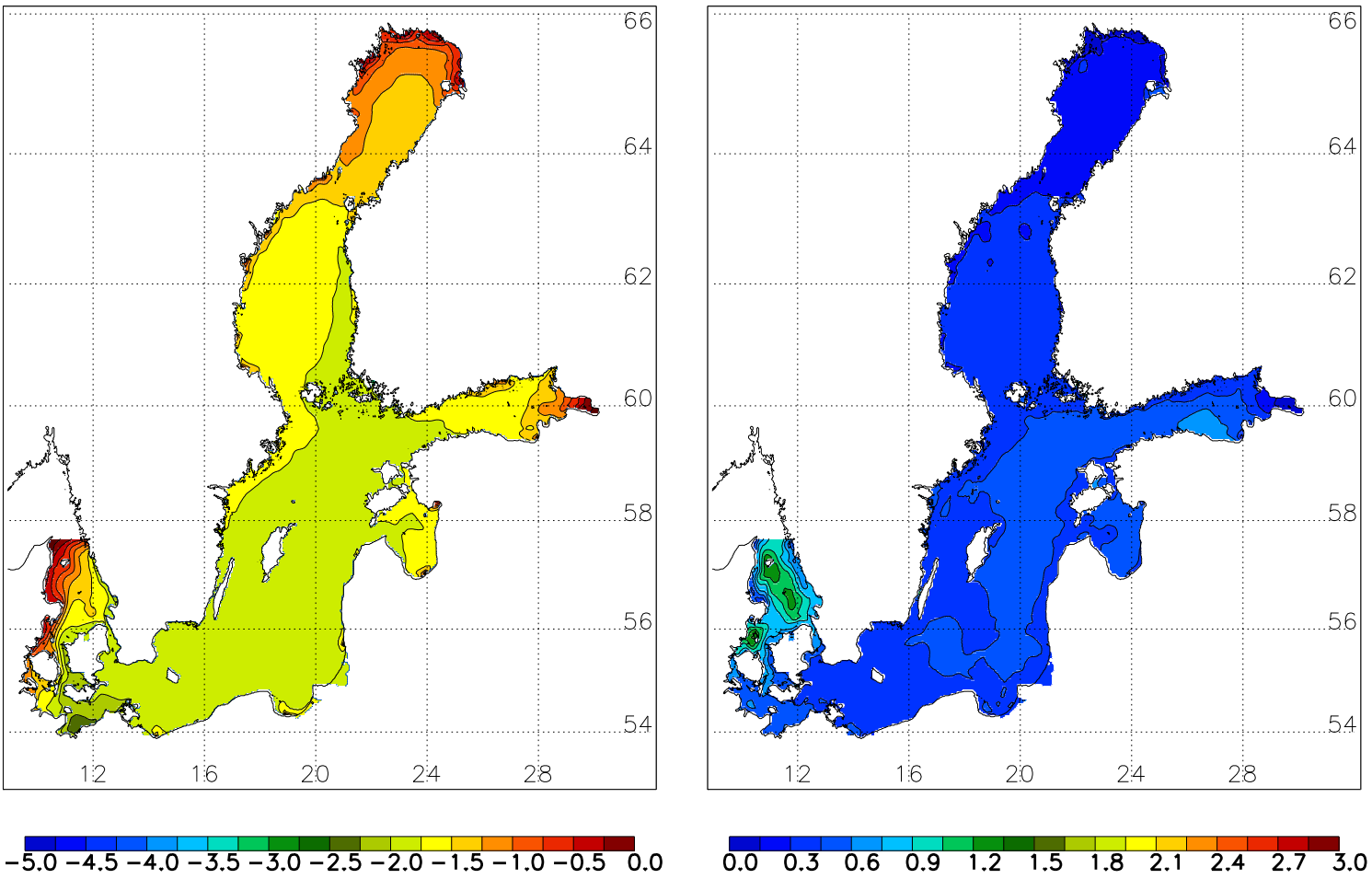

Figure 2:
Left panel: The mean change in annual surface salinity between the periods 2070–2099 and 1969–1998.
Right panel: The range of the changes. (From Meier et al., 2011)

Baltic Proper and in the Gulf of Finland especially along the slopes of the basins. In the Bothnian Bay the changes are smaller. There is no pronounced seasonality. Note that even though the Kattegat does not show any alteration in bottom salinity this is an effect of the prescribed boundary conditions and not an outcome of the simulations.

› The differences between the four simulations are much larger for the bottom salinity than for the surface salinity as demonstrated in the right panel in Figure 3. It is especially in the Bornholm Basin, the Bay of Gdańsk and along the slopes in the Gotland Basin that the scenario projections give different results. Again the seasonality is minor.

› The largest changes, and uncertainties, in the bottom salinity are related to a possible decrease of the halocline depth.

Conclusion

The scenario simulations show a future decrease in both surface and bottom salinity. The decrease is mainly due to an expected increase in river runoff and deepening of the permanent halocline.

A decrease in salinity will have an effect on the existence and distribution of various species in the Baltic Sea (cf. Baltadapt Climate Info #8: Biodiversity and habtitats). The occurrence of major inflows and the stratification has an effect on the oxygen situation in the deeper parts of the Baltic Sea (cf. Baltadapt Climate Info #5: Oxygen content).

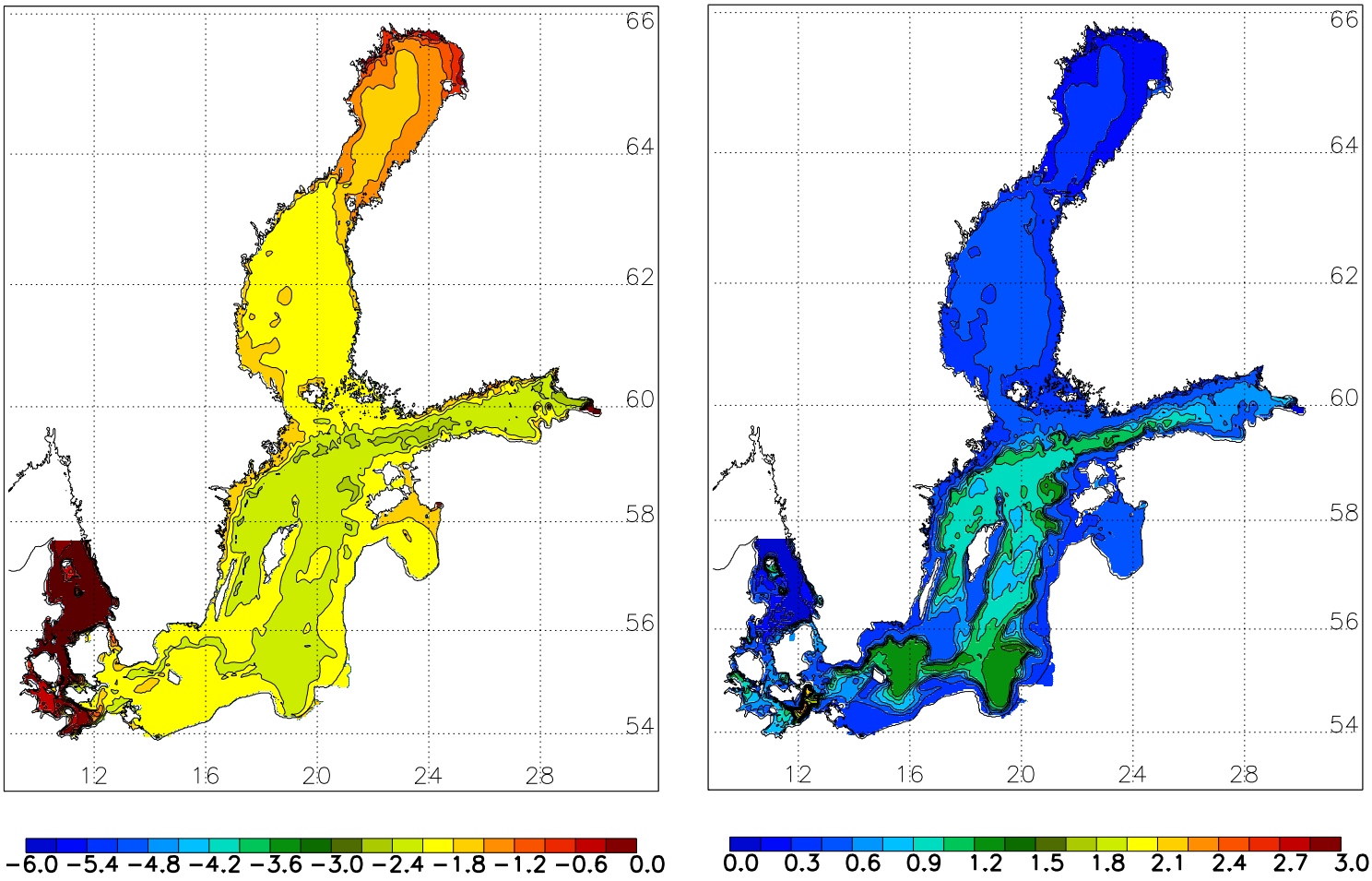

Figure 3:
Left panel: The mean change in annual bottom salinity between the periods 2070–2099 and 1969–1998.
Right panel: The range of the changes. (From Meier et al., 2011)

Climate scenario data

Four simulations of the changing conditions in the Baltic Sea between the periods 2070–2099 and 1969–1998 have been carried out using a coupled physical-biogeochemical model, RCO-SCOBI (Meier et al., 2011). The scenarios cover the Baltic Sea region and have a spatial resolution of 3.7 km.

The model is forced by a regional climate model which, in turn, obtains data on its boundaries from a General Circulation Model (GCM), see more in Baltadapt Climate Info #1. Two different GCMs and two different emission scenarios have been combined to form the four climate simulations.

The emission scenarios chosen are A1B and A2 which are characterized by the following storylines:

- A1B: "a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies with a balance across energy sources".
- A2: "a very heterogeneous world with continuously increasing global population and regionally oriented economic growth that is more fragmented and slower than in other storylines".

One should note that other combinations of GCMs and emission scenarios, and other regional models, may give different results.

References and further reading

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The Baltadapt project in a nutshell

The Baltic Sea and its coastlines face challenges due to climate change. The projected increase in precipitation amounts and temperature will jeopardize the integrity of the ecosystem and increase risks caused by natural disasters. Adaptation strategies are needed to cope with the inevitable consequences of climate change. Baltadapt is developing a transnational climate change adaptation strategy for the Baltic Sea Region. This will help decision makers allover the region to tackle the consequences of climate change.

The project was approved under the Baltic Sea Region Programme 2007–2013 and has a total budget of € 2.86 m. Its partner consortium is led by the Danish Meteorological Institute. Baltadapt is a flagship project under the EU Strategy for the Baltic Sea Region and has been awarded the Baltic 21 Lighthouse Project quality label.