Baltic-C: Modeling and experimental approaches to unravel the Baltic Sea carbon(CO_2) cycle and its response to anthropogenic changes

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Baltic-C

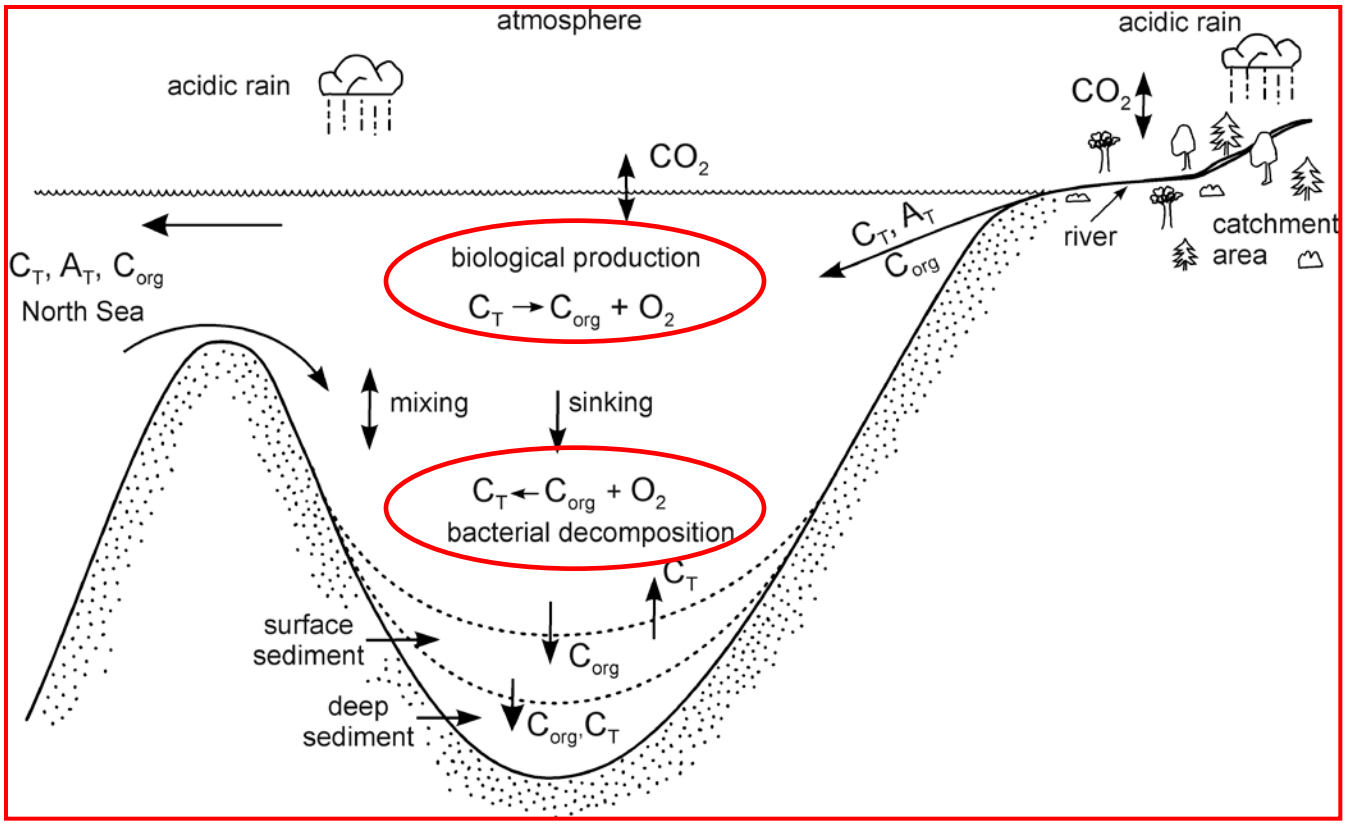
Building predictive capability regarding the Baltic Sea organic/inorganic carbon and oxygen systems

Baltic-C Kick off meeting
Gothenburg November 2008

Motivation:

1.) Eutrophication: „ an increase in the rate of supply of organic matter to an ecosystem“ (Nixon, 1995)

2.) Acidification

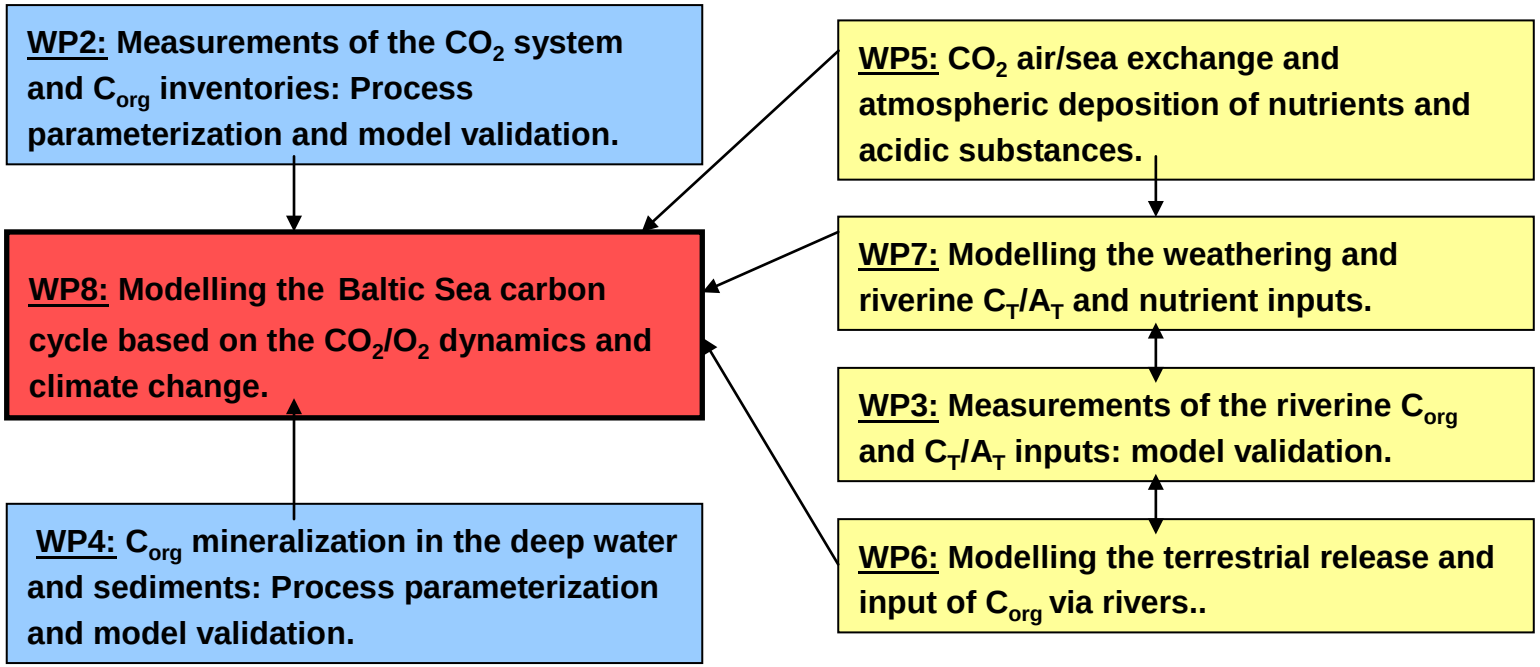


Nixon, S.W., Coastal marine eutrophication: A definition, social causes, and future concerns. Ophelia 41: 199 -219 (1995)

Structure of Baltic-C

The Baltic Sea carbon cycle: present state and future development.

External forcing, affected by climate change and anthropogenic activities.

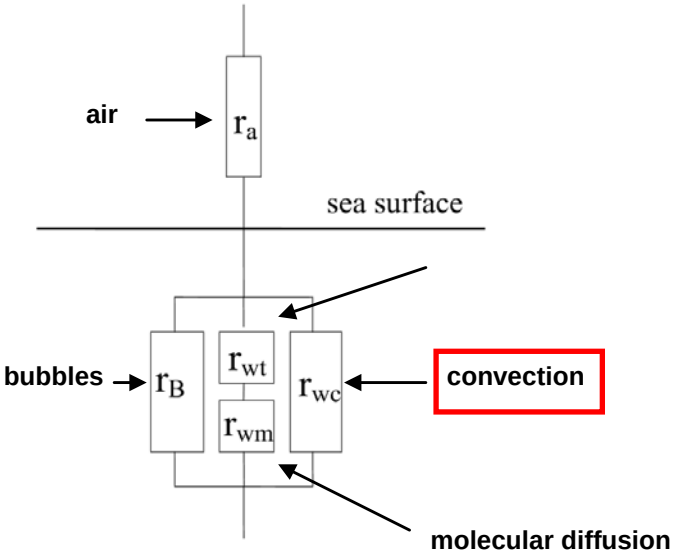


Biogeochemical forcing: Atmosphere

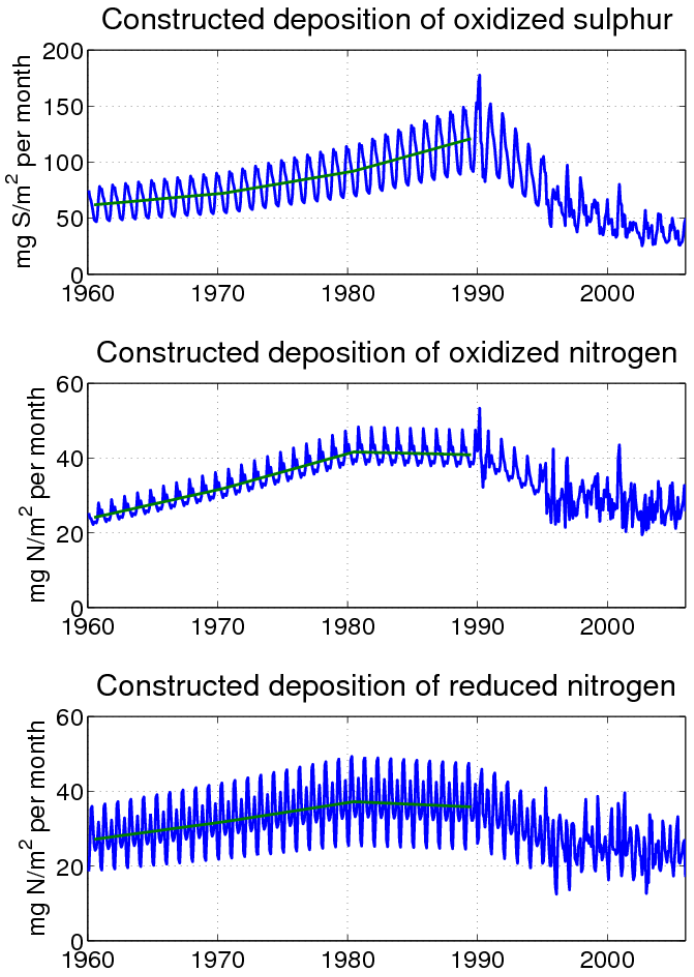
A. Rutgersson, B. Claremar, M. Norman, Erik Sahlee

Physically based parameterisation of the gas exchange transfer velocity including the impact of convection:

Gas exchange resistances:



Reconstruction of the atmospheric deposition of nutrients and acidic substances 1960 to 2006 Baltic Sea drainage basin:

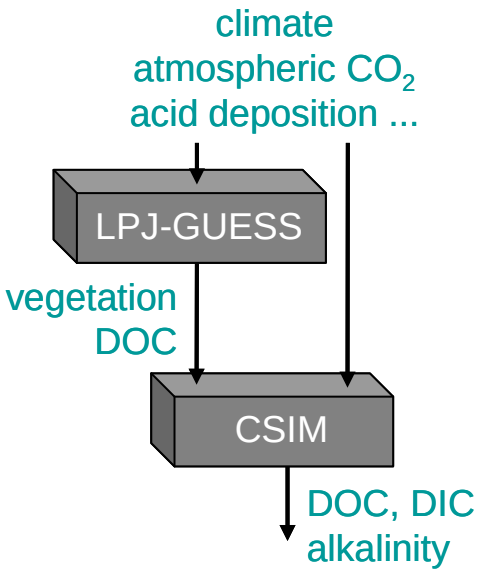


Biogeochemical forcing: Catchment

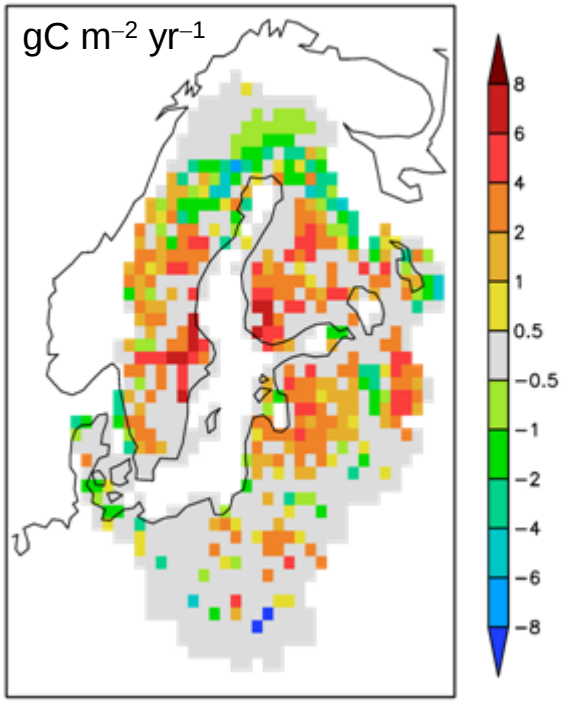
Organic carbon: B. Smith, G. Schurgers

Inorganic carbon: C. Humborg, C.-M. Mörth, T. Wällstedt

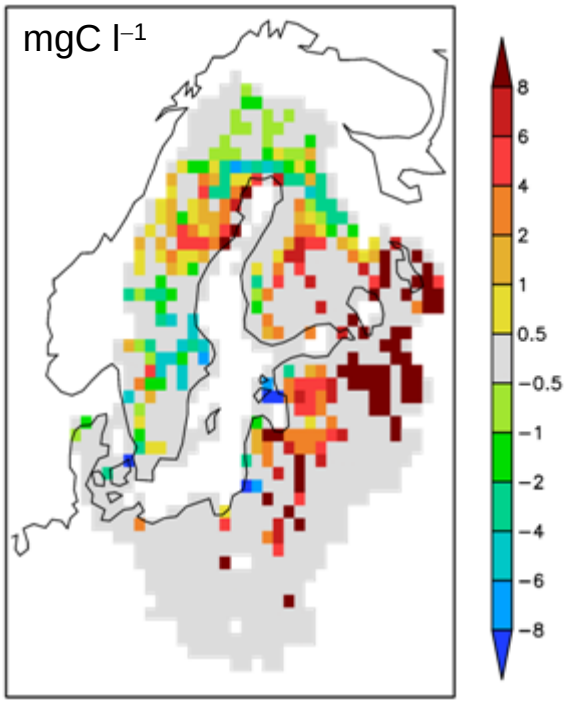
The model system:



Δ DOC production
(1996-2005)–(1976-1988)
LPJ-GUESS

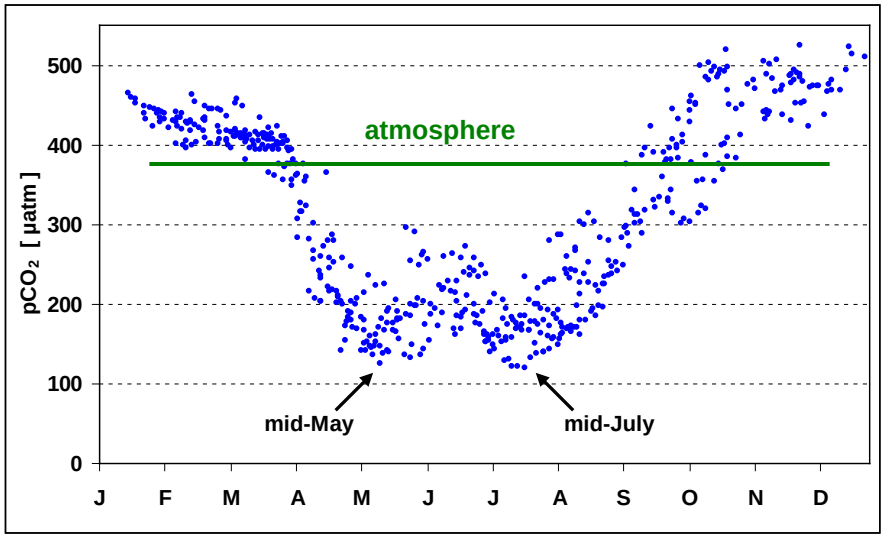


Δ runoff DOC concentration
(1996-2005)–(1976-1988)
LPJ-GUESS



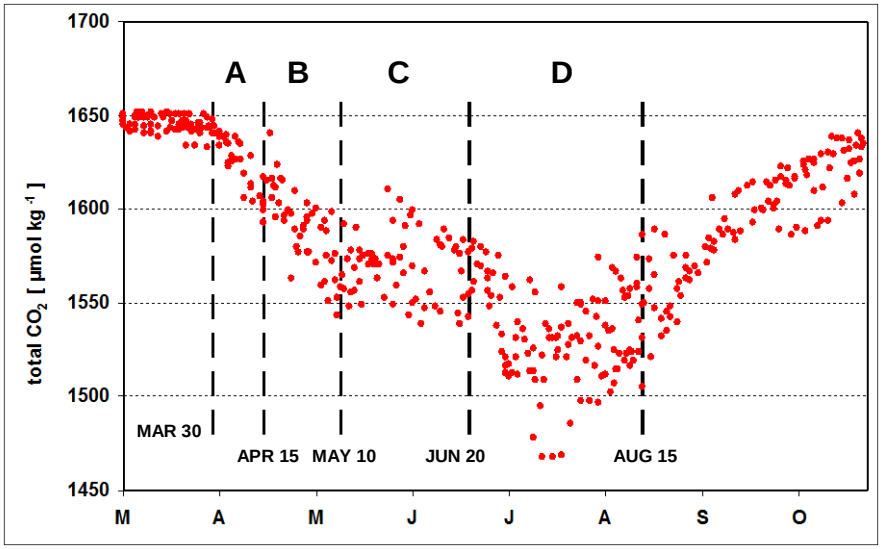
The Baltic Sea carbon cycle – Experimental approach:

A. The Baltic Sea CO_2 system (B. Schneider, A. Löffler)



Continuous measurements of the CO_2 partial pressure on a cargo ship:

→ **The Baltic Proper is a sink for atmospheric CO_2;**



Calculation of the surface water total CO_2:

→ **Determination of organic carbon production and its relationship to nutrient availability for different production periods:**

A: Nitrate bloom

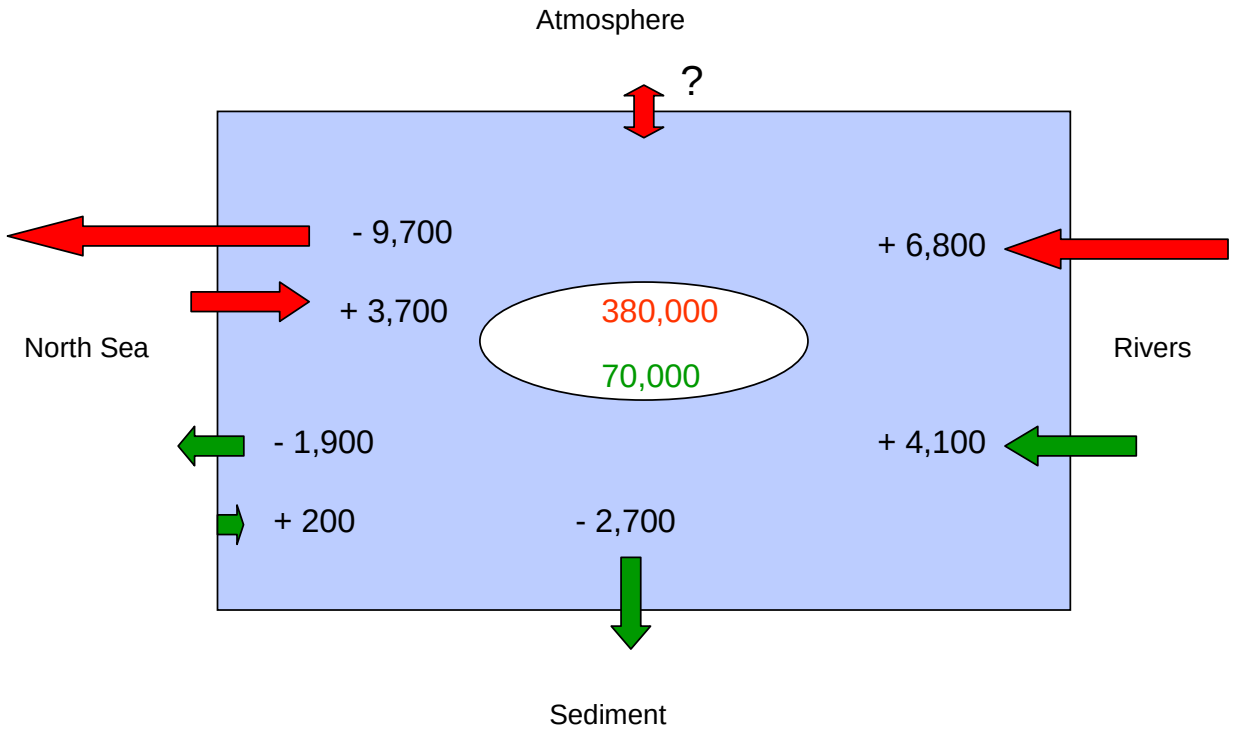
B: Post-nitrate bloom

C: Regenerated production

D: Mid-summer nitrogen fixation periodn periods:

B. The Baltic Sea carbon budget

(J. Pempkowiak, K. Kulinski, A. Maciejewska, A. Szczepanska, M. Perttilä)



Fluxes of inorganic carbon (red) and organic carbon (green) are given in kt/yr and the inventories (encircled) refer to kt.

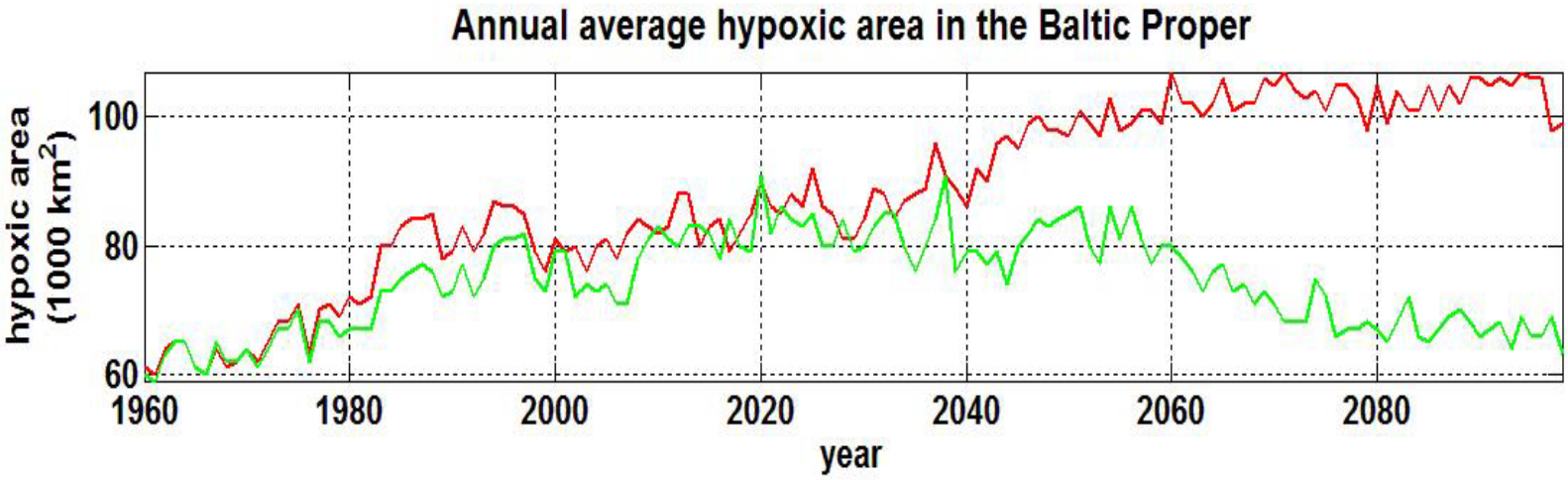
The Baltic Sea carbon/oxygen cycle – Model simulations:

Two scenario combinations:

1.) CO_2 scenario A2 (850 ppm); nutrient inputs according to business as usual (red);

2.) CO_2 scenario B1 (550 ppm); nutrient inputs according to the Baltic Sea Action Plan (green);

Oxygen:

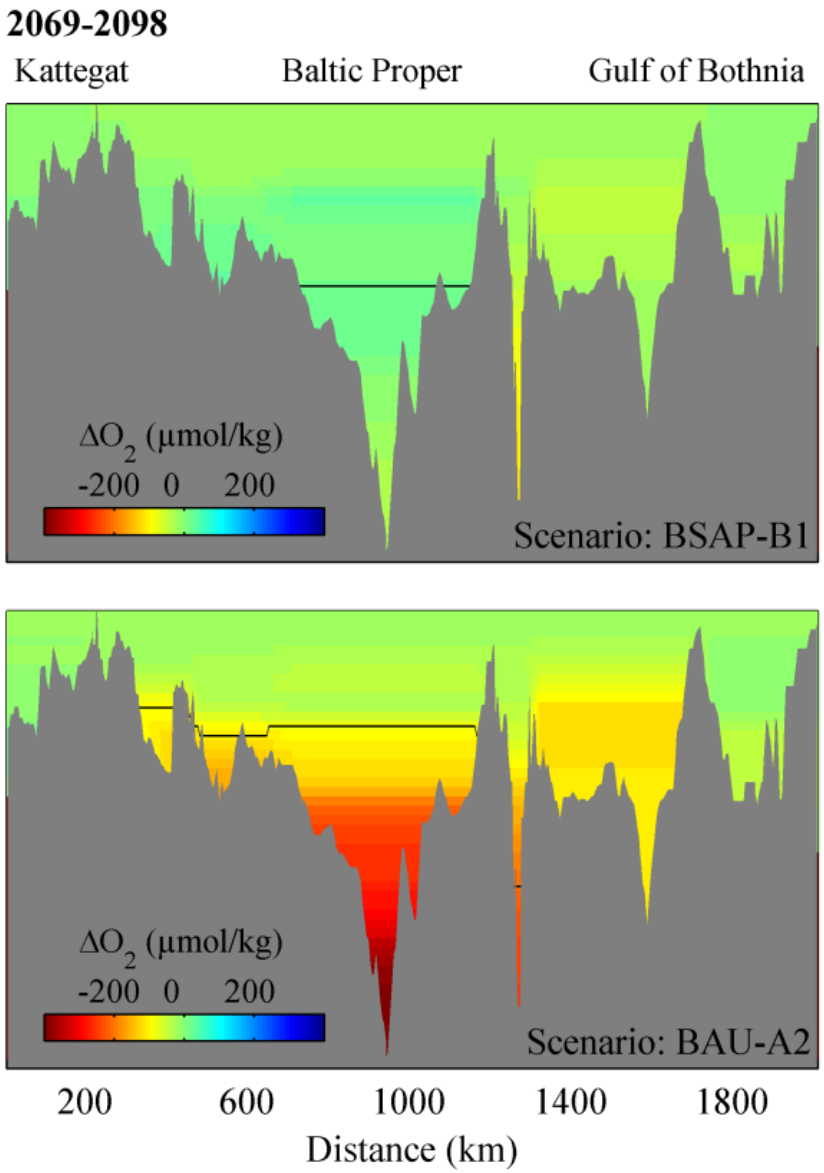


Nutrient inputs according to the Baltic Sea Action Plan will stop the extension of hypoxic area in the Baltic Proper!

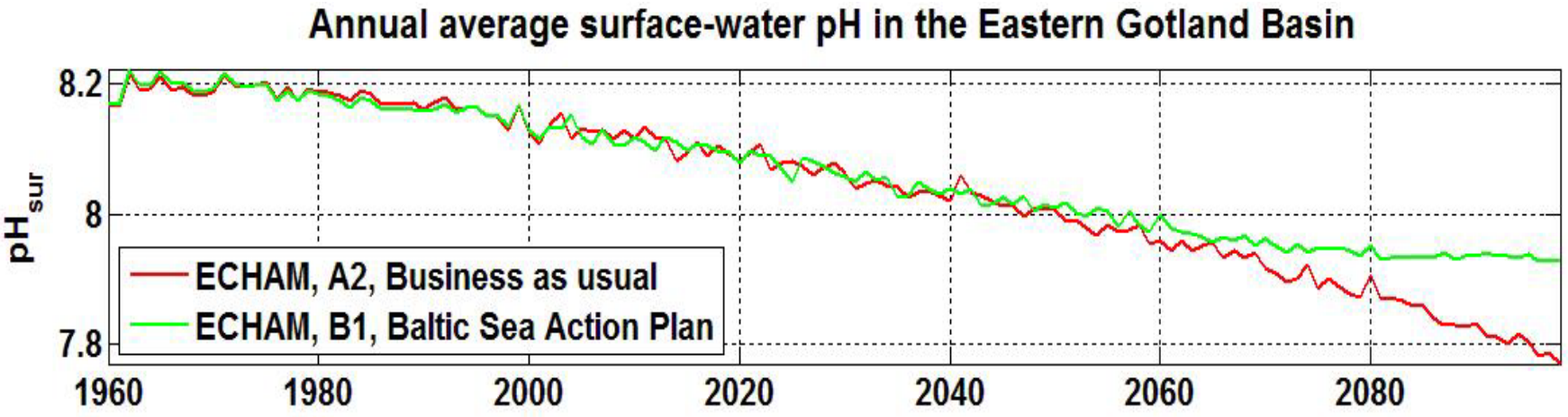
Decrease in O_2 concentrations until the end of the 21st century

Baltic Sea Action Plan:

Business as usual:



Acidification:



The change in pH is mainly controlled by the increase of atmospheric CO_2, climate change and changes in input from land (nutrients) have no clear effect.

Decrease in pH until the end of the 21st century

Atmospheric CO_2: 550 ppm:

Atmospheric CO_2: 850 ppm: