Advanced modeling tool for scenarios of the Baltic Sea ECOsystem to SUPPORT decision making (ECOSUPPORT, 2009-2011)

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Baltic Sea - how to approach the future?

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Advanced modeling tool for scenarios of the Baltic Sea ECOsystem to SUPPORT decision making

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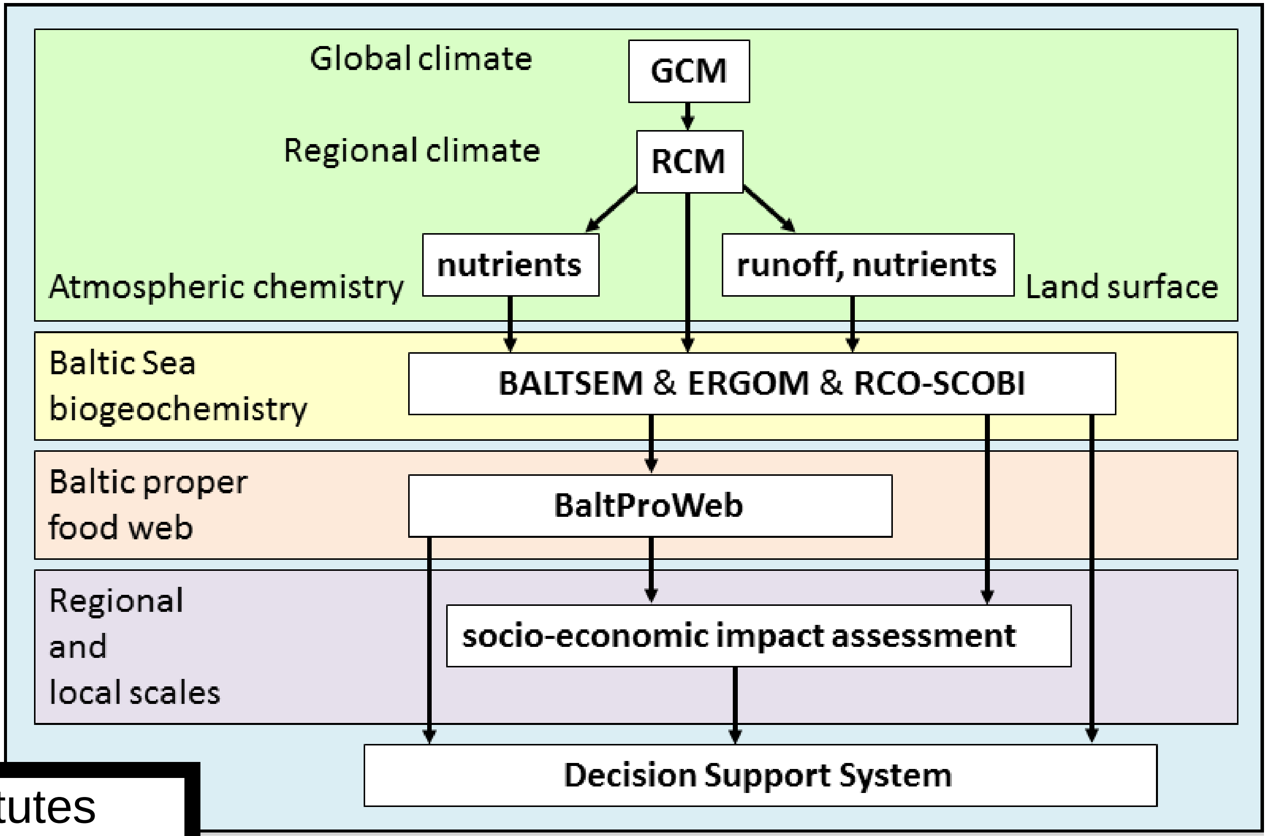

11 partner institutes from 7 Baltic Sea countries
2009-2011

www.baltex-research.eu/ecosupport

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SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

Baltic Sea - how to approach the future?

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IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO UNEP

Combined effects of climate change and nutrient loads

Ensemble modelling to quantify uncertainty

Decision support to policy makers

Baltic Sea: future projections

- 4 climate projections 1961-2099
- 2 different global climate models
- A1B and A2 scenarios
- 2 realizations
- 1(2) regional climate model (RCAO, CLM)
- 1(2) hydrological models
- 3 Baltic Sea models (BALTSEM, ERGOM, RCO-SCOBI)
- 3(4) nutrient load scenarios: BSAP, (CLEG), REF, BAU
- Total: 38(58) scenario simulations

Present climate

Model evaluation 1970-2005

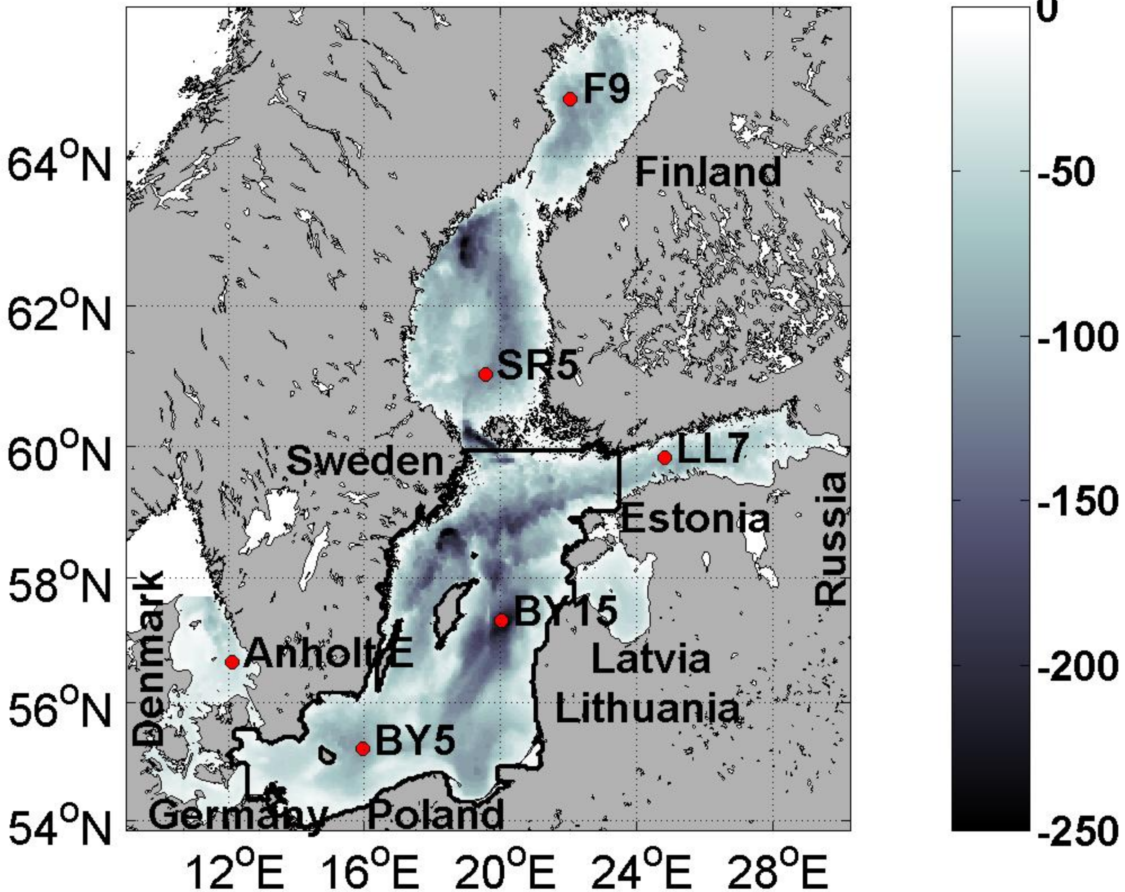
- **Coupled physical-biogeochemical models**

1. RCO-SCOBI	(3D, 2nm)	SMHI	Sweden
2. BALTSEM	(1D, 13 basins)	BNI	Sweden
3. ERGOM	(3D, 3nm)	IOW	Germany

- **Atmospheric forcing 1961-2006 (ERA40-RCA)**
  - High sensitivity of the Baltic Sea to the atmospheric forcing.

- **Validation data 1970-2005**
  - Baltic Environmental Database (BED).

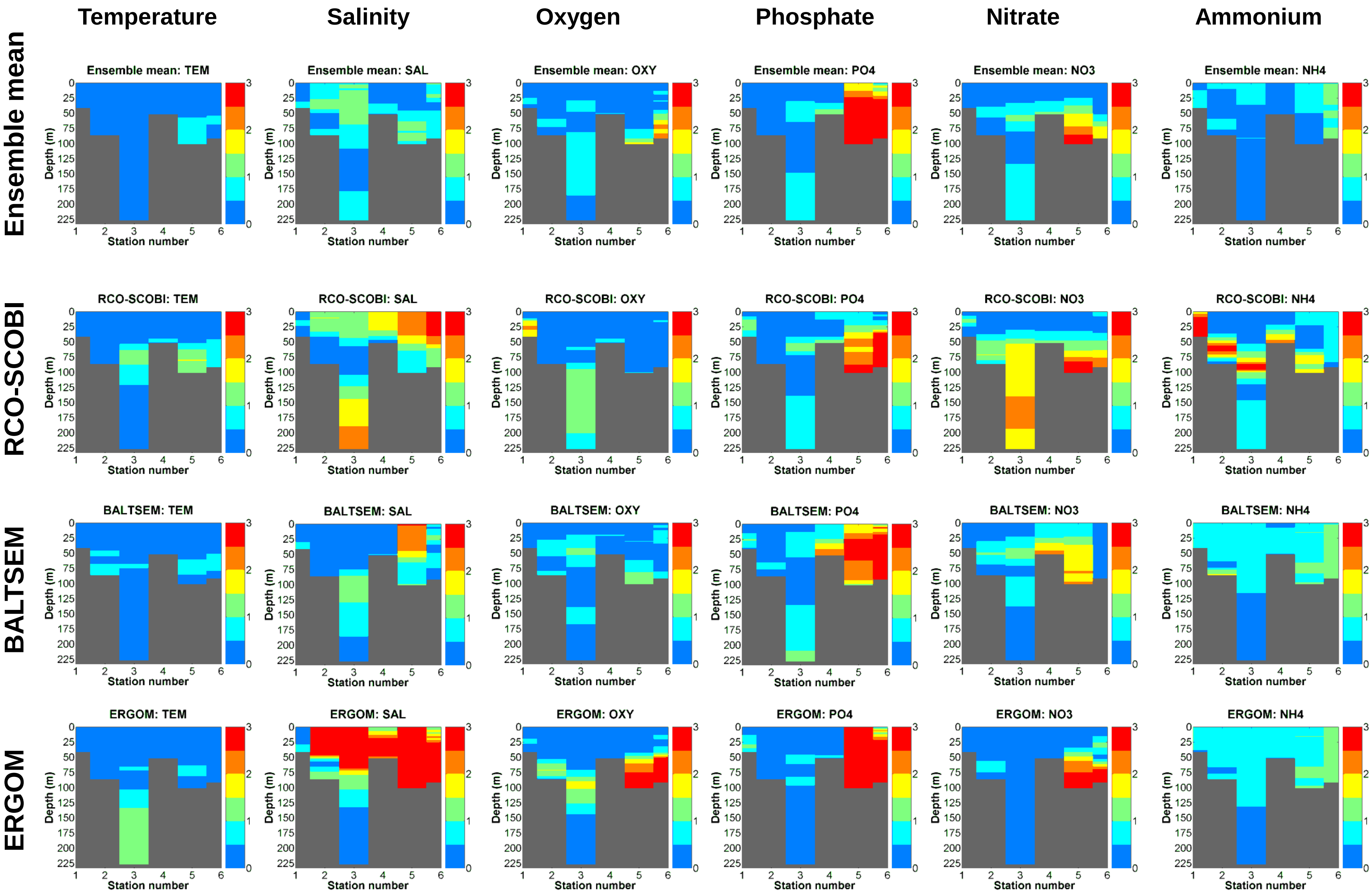
Model evaluation 1970-2005

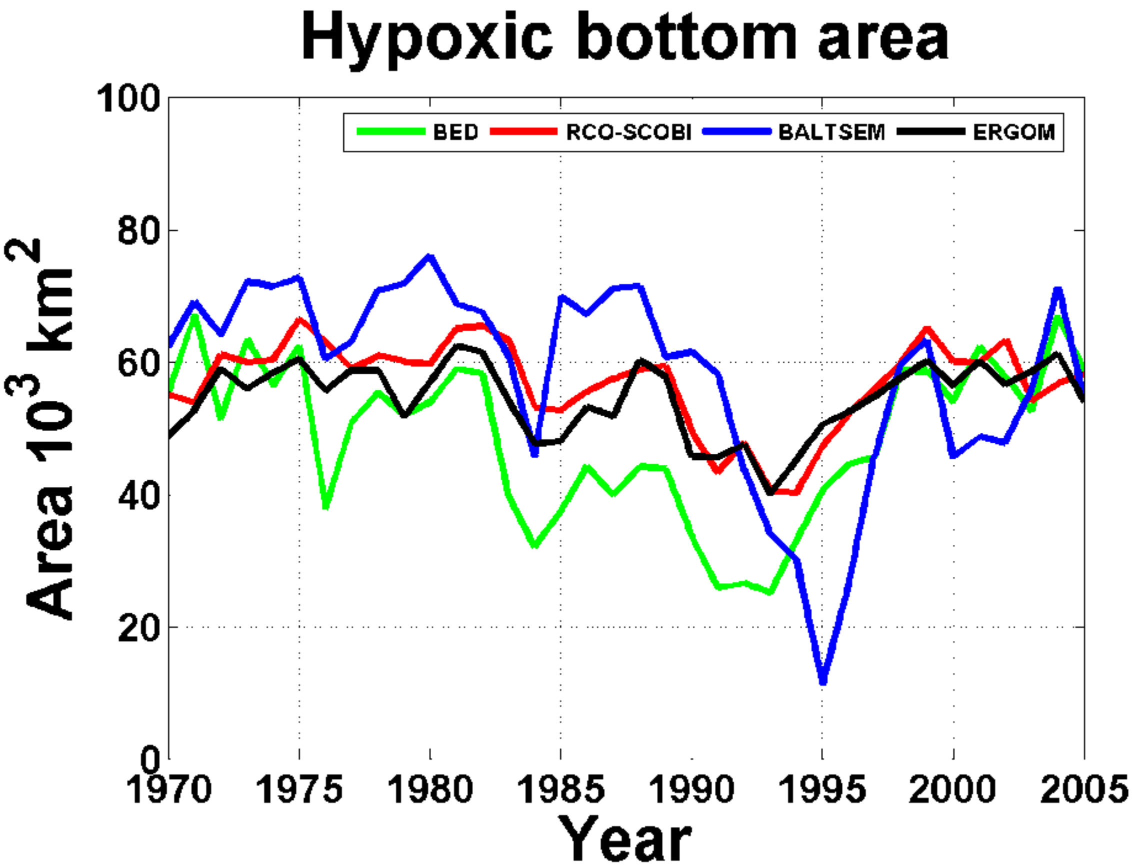


Baltic Sea

- Bathymetry
- 6 stations
- Baltic proper

(Source: Eilola et al., 2011)

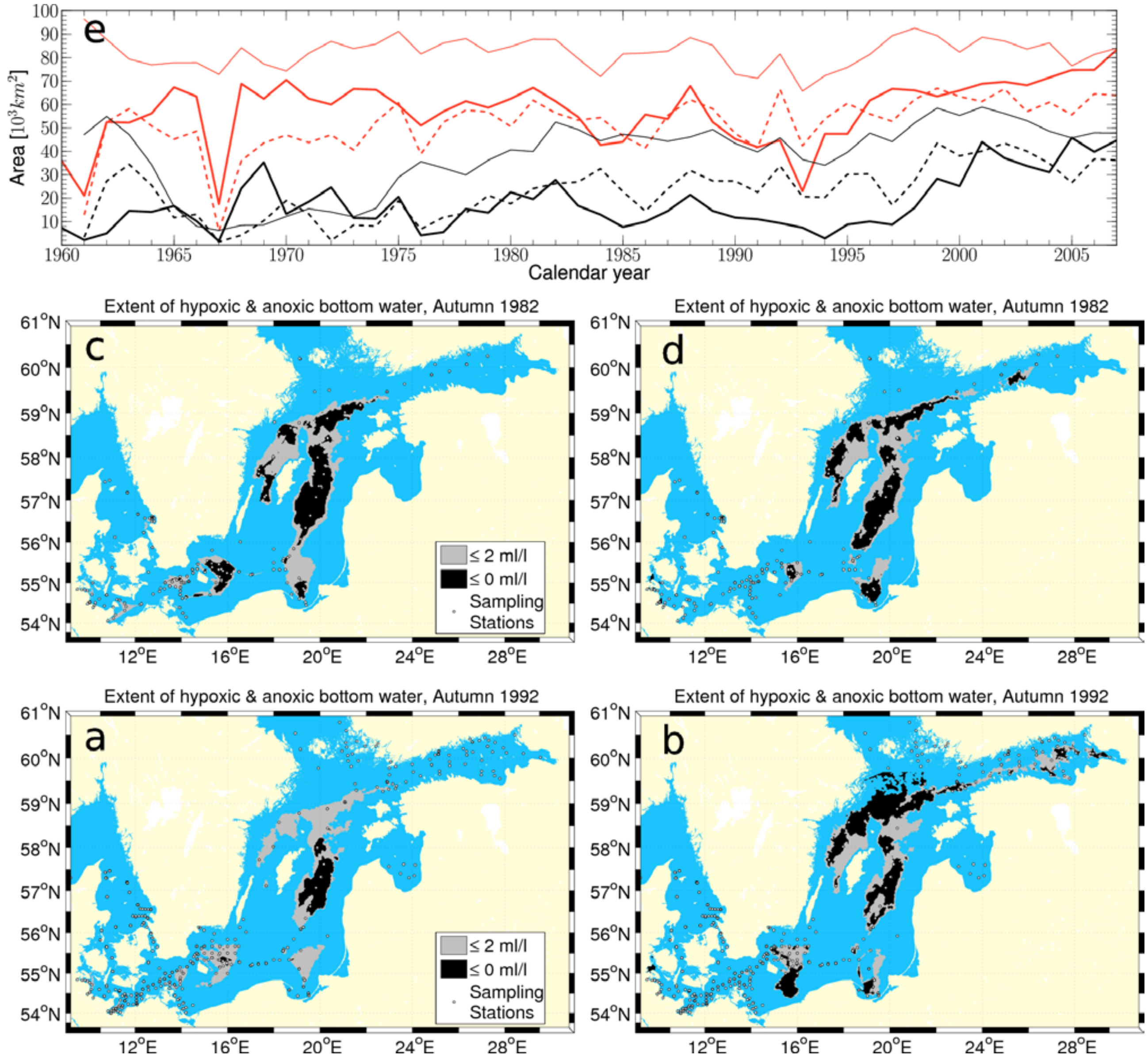




Annual averages of the integrated hypoxic area in the Baltic proper. The green solid line indicates the mean value of BED data. The red, blue and black lines show the mean values of the RCO-SCOBI, BALTSEM and ERGOM models, respectively.

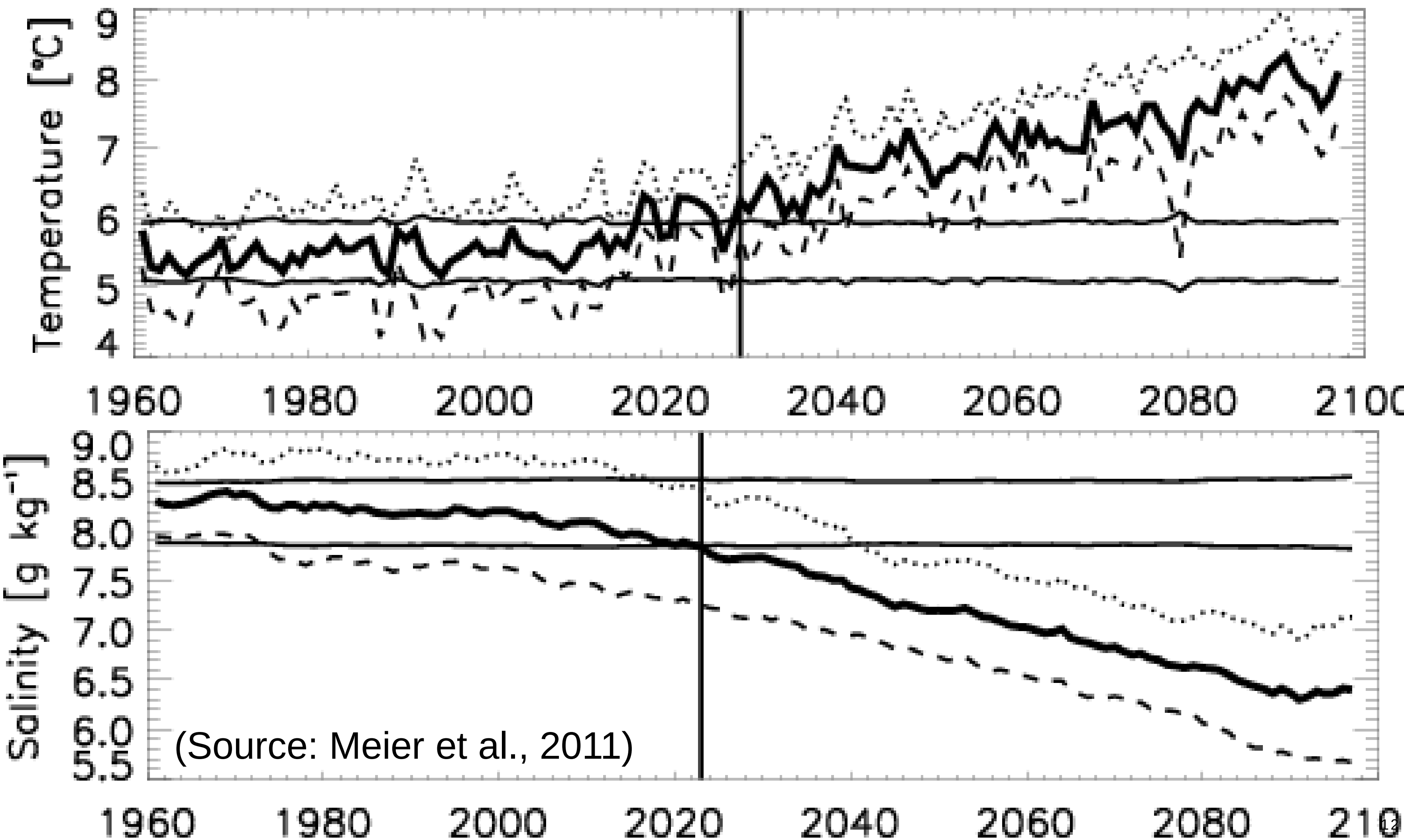
Records of hypoxia and anoxia in RCO-SCOBI (thin), observations (thick) and model results at observed stations (dashed)

(Source: Väli et al.)



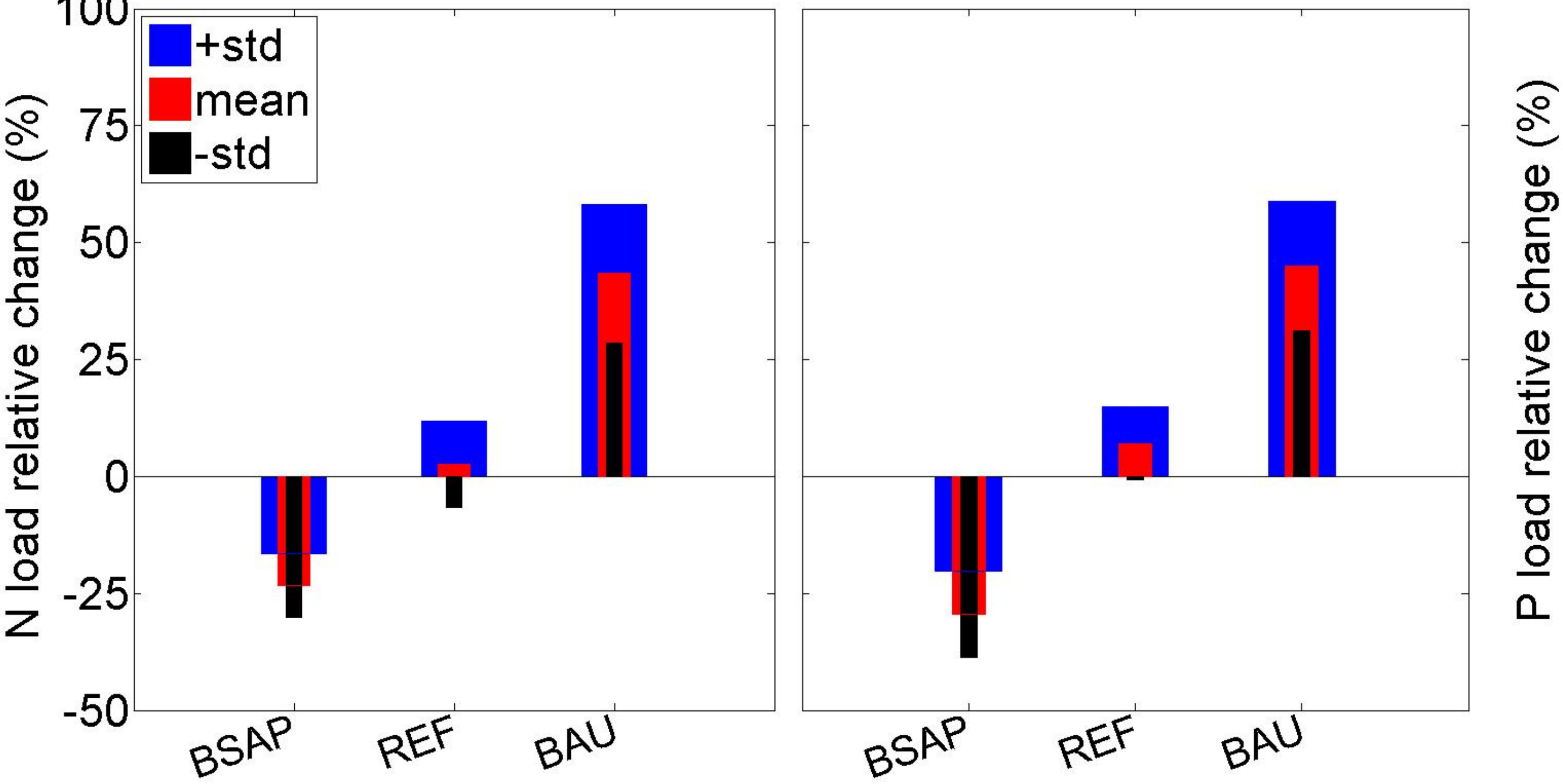
Future climate

Ensemble mean volume averaged temperature and salinity



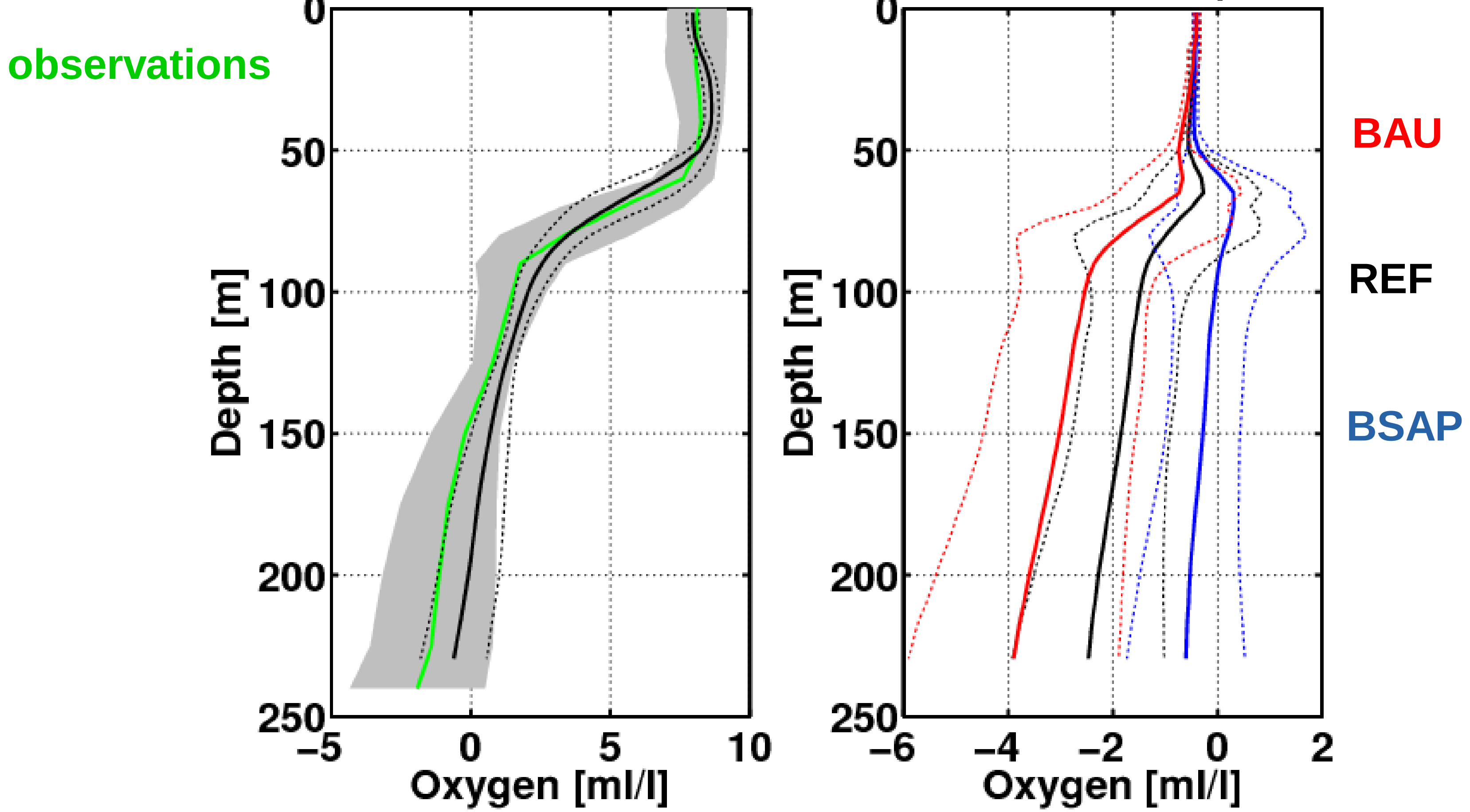
(Source: Meier et al., 2011)

Ensemble average changes of the annual mean biologically available total nitrogen and phosphorus loads



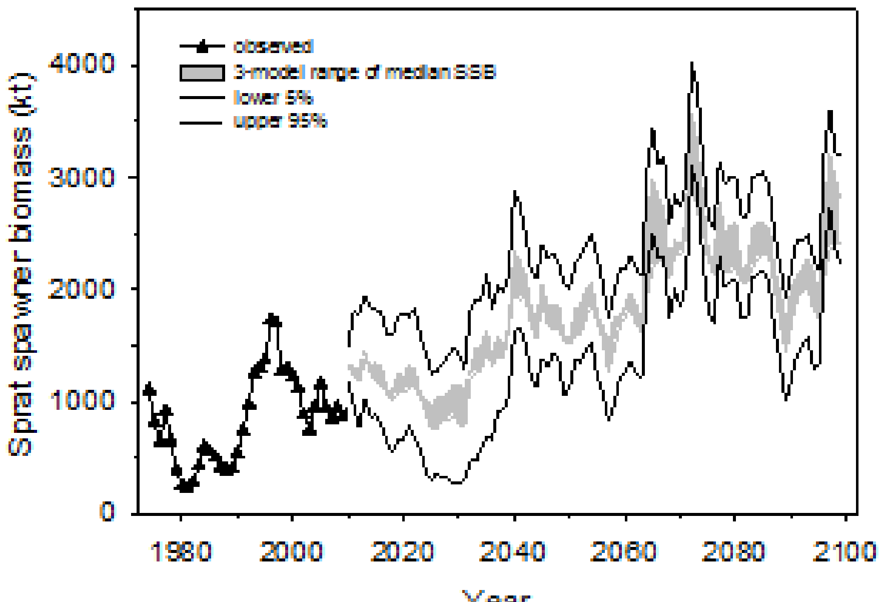
(Source: Meier et al., 2011)

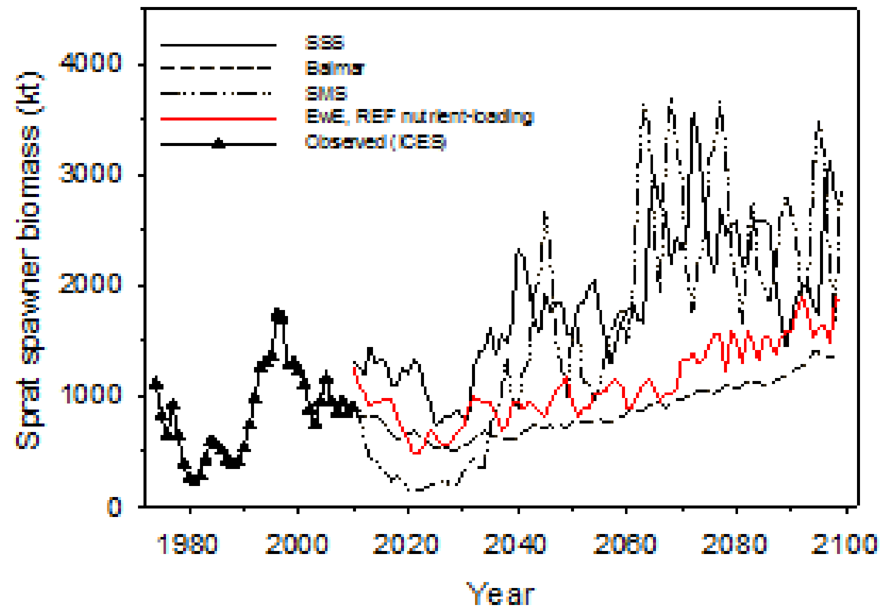
Ensemble average vertical profiles and changes between 2069–2098 and 1978–2007 in oxygen concentration at Gotland Deep



(Source: Meier et al., 2011)

Projections of higher trophic levels (sprat)





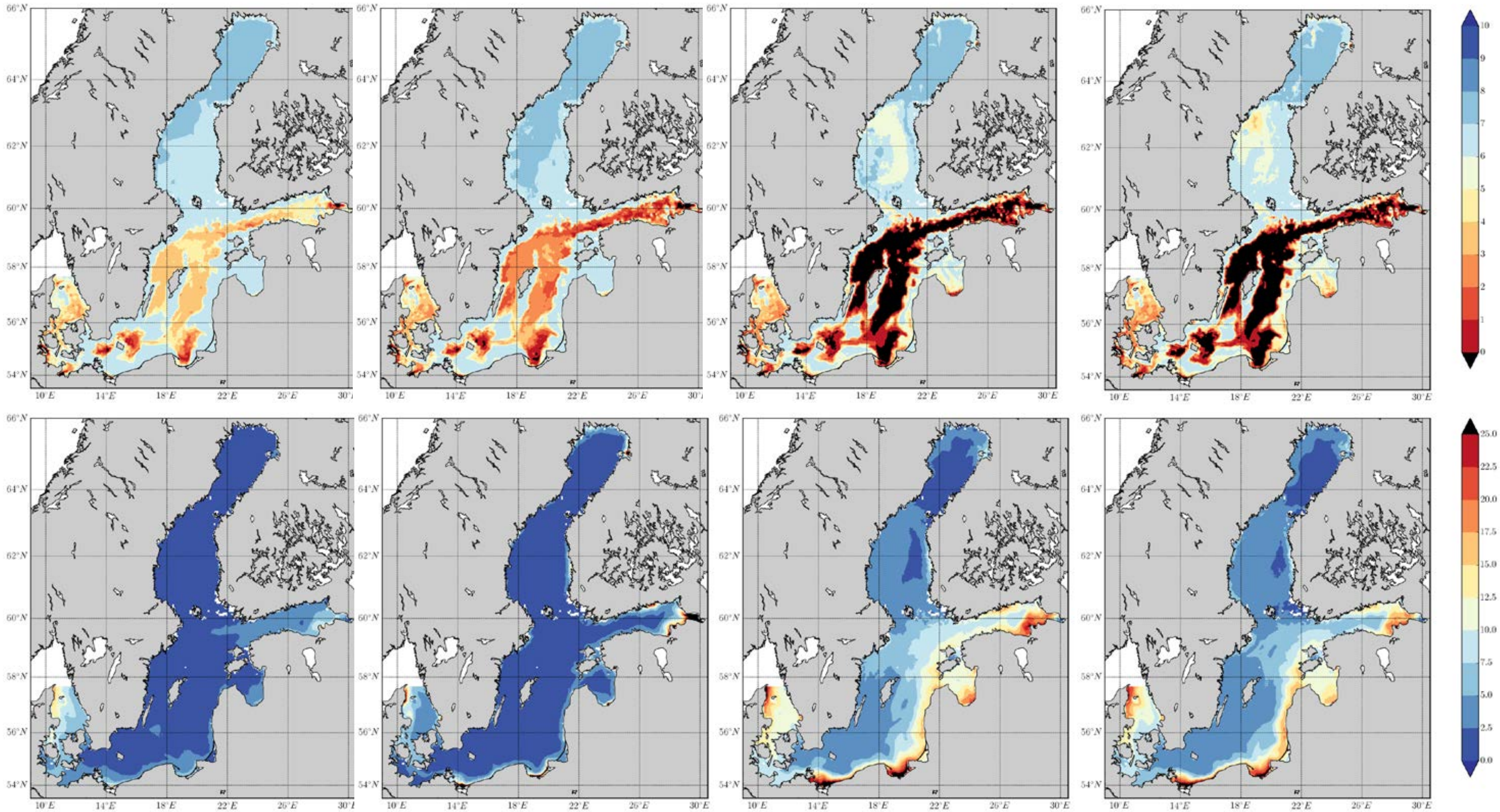
(Source: MacKenzie et al., 2012; in preparation)

Projected spawner biomass of sprat in the Baltic Sea assuming a temperature – driven spawner-recruit relationship with temperatures estimated from three different climate-oceanographic models. Fishing mortality of sprat was at a currently defined sustainability level and natural mortality was assumed equal to the mean level during 2008-2010.

Different population and food web models. All projections use the A1B emission scenario, ECHAM5 climate forcing and the RCO-SCOBI oceanographic-biogeochemical model.

Past climate

1897-1906 **1947-1956** **1977-1986** **1997-2006**



Decadal averaged bottom oxygen concentrations (top row) and July–August phytoplankton biomass in the upper 10 m of the water column (bottom row) in RCO-SCOBI.

(Source: Meier et al., 2012b)

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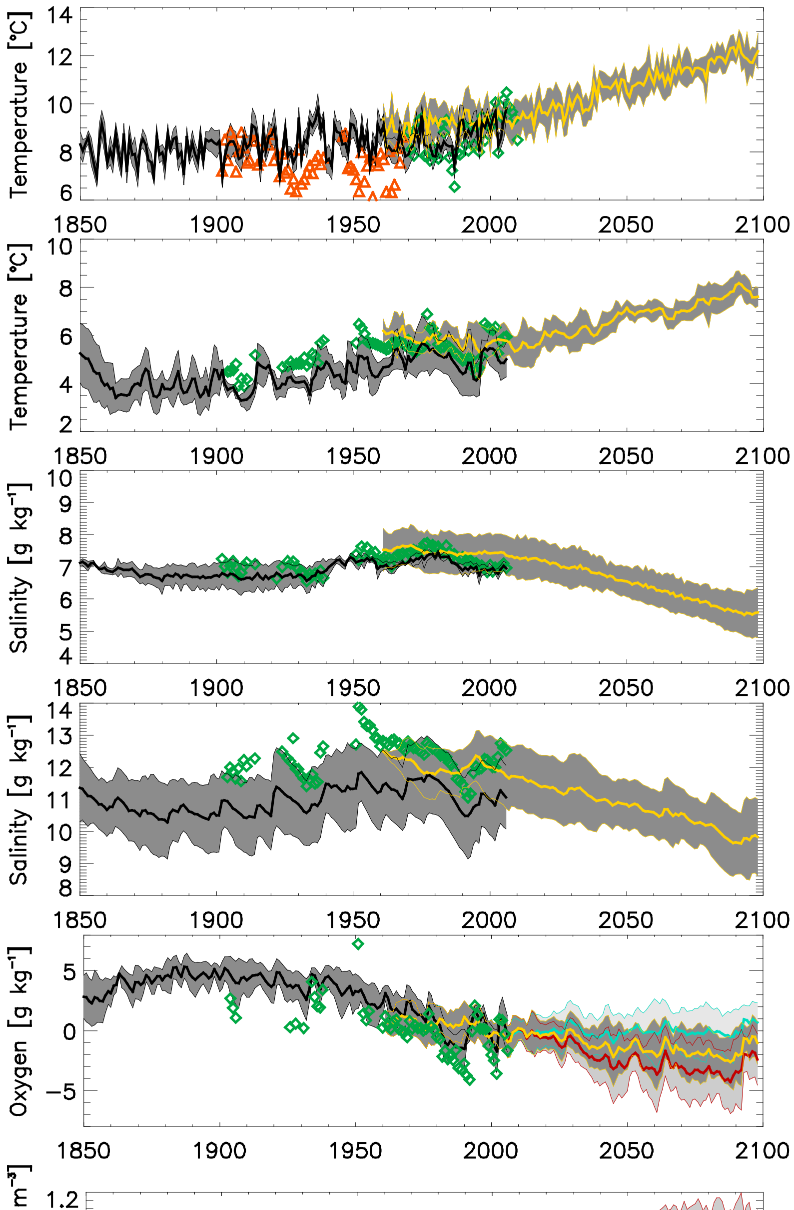
Simulated ensemble averages and observed annual mean water temperatures ((a), (b)) and salinities ((c), (d)) at Gotland Deep at 1.5 and 200 m depth, annual mean oxygen concentrations at 200 m depth (e), and winter (January–March) mean surface phosphate (f) and nitrate (g) concentrations. Shaded areas denote the ranges of plus/minus one standard deviation around the ensemble averages. The various nutrient load scenarios (1961–2098) are shown by colored lines (REF—yellow, BSAP—blue, BAU—red) and the reconstruction (1850–2006) by the black line. For comparison, observations from monitoring cruises at Gotland Deep (green diamonds, in panel (a) since 1970 only) and from the light ship Svenska Björn, operated during 1902–1968 (orange triangles in panel (a)), were used.



(Source: Meier et al., 2012b)

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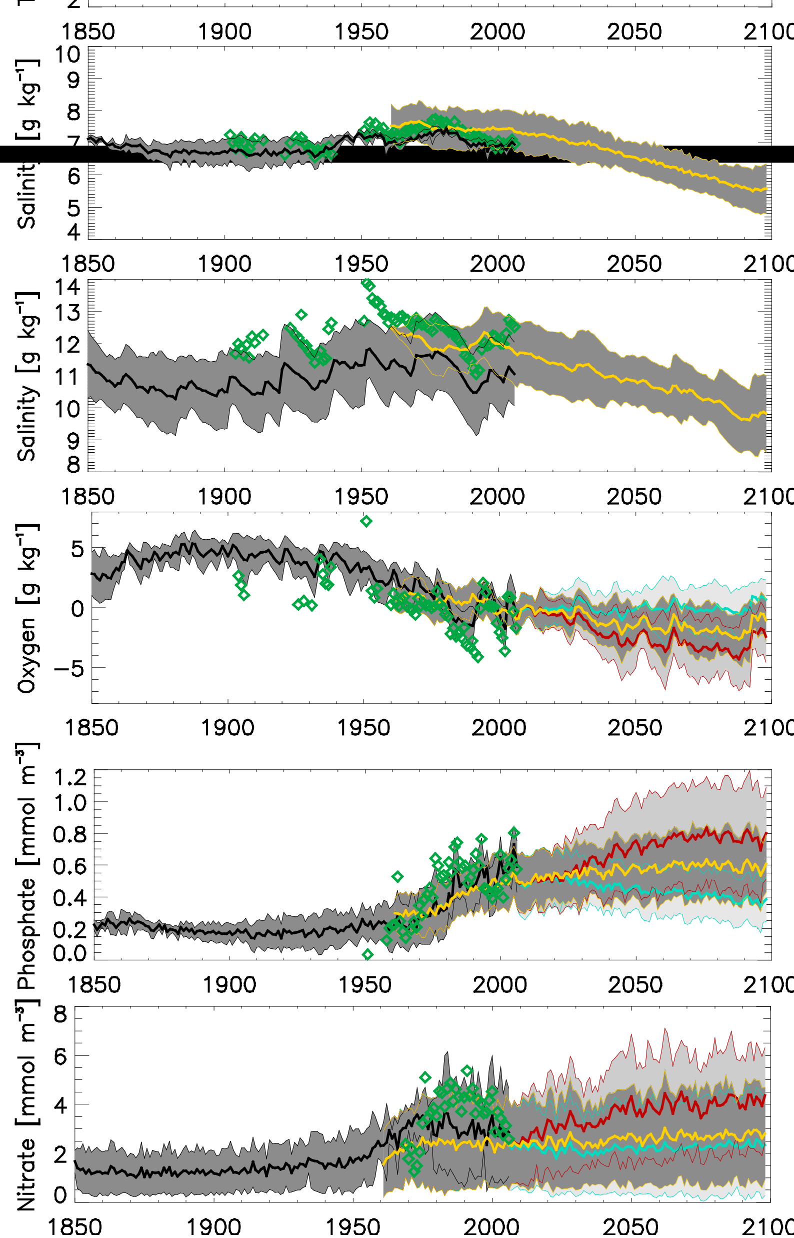

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Conclusions

- **State-of-the-art biogeochemical models are capable to simulate past climate variations and eutrophication since 1850.**

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- **State-of-the-art biogeochemical models are capable to simulate past climate variations and eutrophication since 1850.**
- **The biogeochemical models show good quality in the Baltic proper but fail in the northern Baltic Sea.**

Conclusions

- **In future climate, increased loads and temperature dependent rates of biogeochemical processes may result in an overall intensification of internal nutrient cycling, including substantial increases in both primary production of organic matter and oxygen consumption for its mineralization.**

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Conclusions

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- **In future climate, increased loads and temperature dependent rates of biogeochemical processes may result in an overall intensification of internal nutrient cycling, including substantial increases in both primary production of organic matter and oxygen consumption for its mineralization.**
- **Without drastic nutrient load abatements hypoxic and anoxic areas are projected to increase.**

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Conclusions

- **Uncertainties of the projections are dominated by unknown nutrient loads, biases of the GCMs and biases of the biogeochemical models. For instance, we found largely differing sensitivities of the models to changing nutrient loads.**

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Conclusions

- **The uncertainty due to incompletely understood ecological processes within the fish population models is in general larger than the uncertainty due to differences among the three oceanographic-biogeochemical models that force the fish models.**

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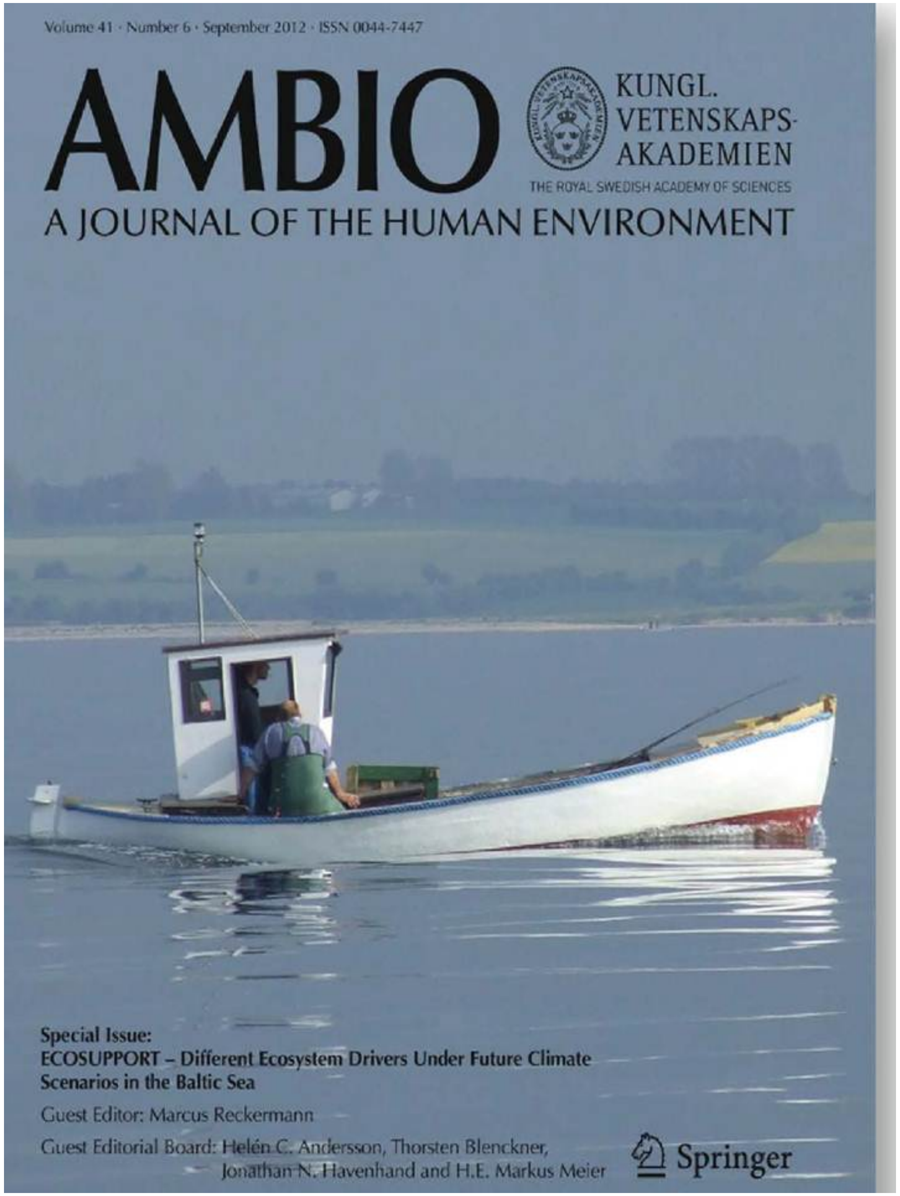
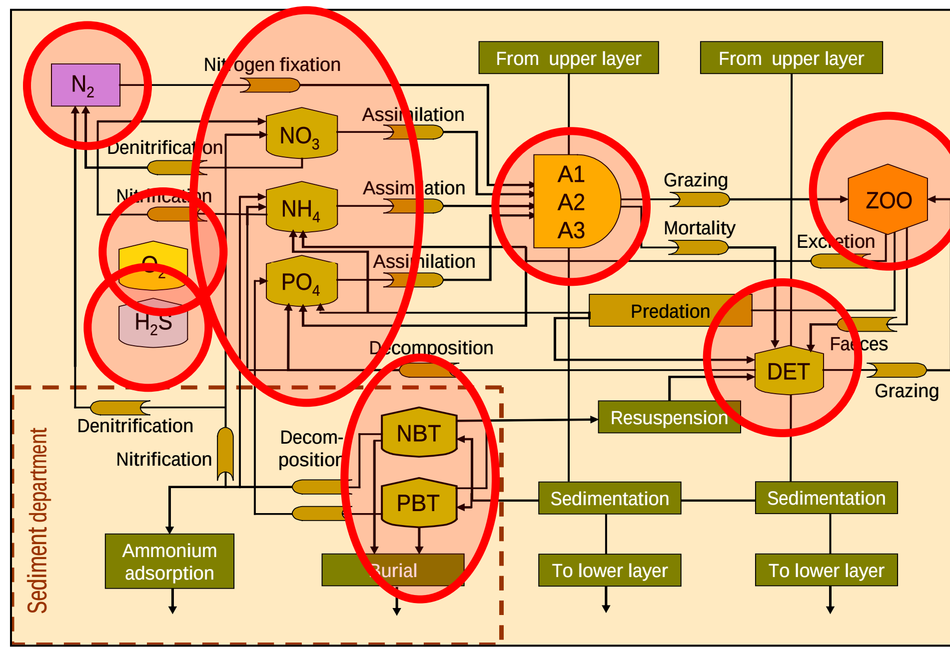


RCO – SCOBI High resolution (2nm) 3-D model for biogeochemical climate- and process studies in the Baltic Sea

The model handle dynamics of nitrogen, oxygen and phosphorus for example including:

- **inorganic nutrients**
- **nitrogen fixation**
- **particulate organic matter**
- **sediment**
- **oxygen**
- **hydrogen sulphide**
- **resuspension**



Resuspension

of sediments