Challenges for biogeochemical modeling on centennial time scales

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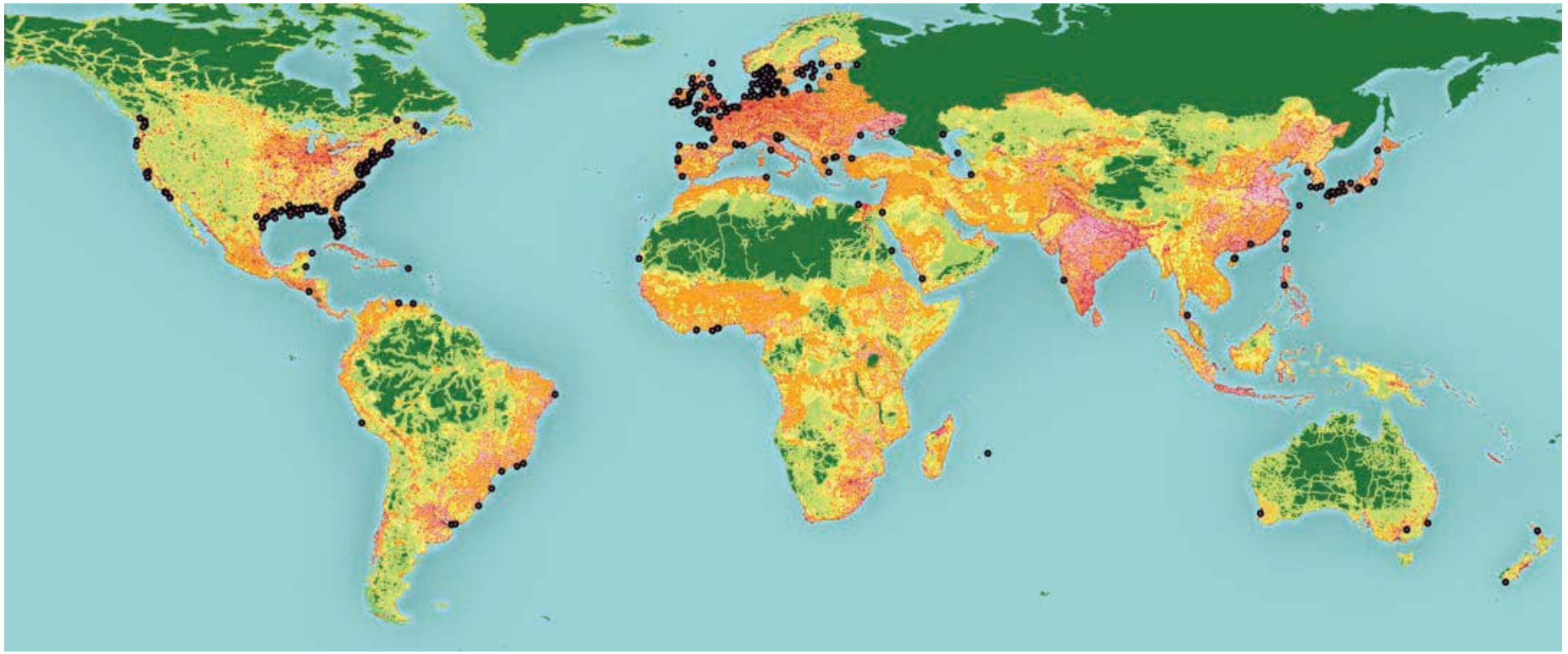
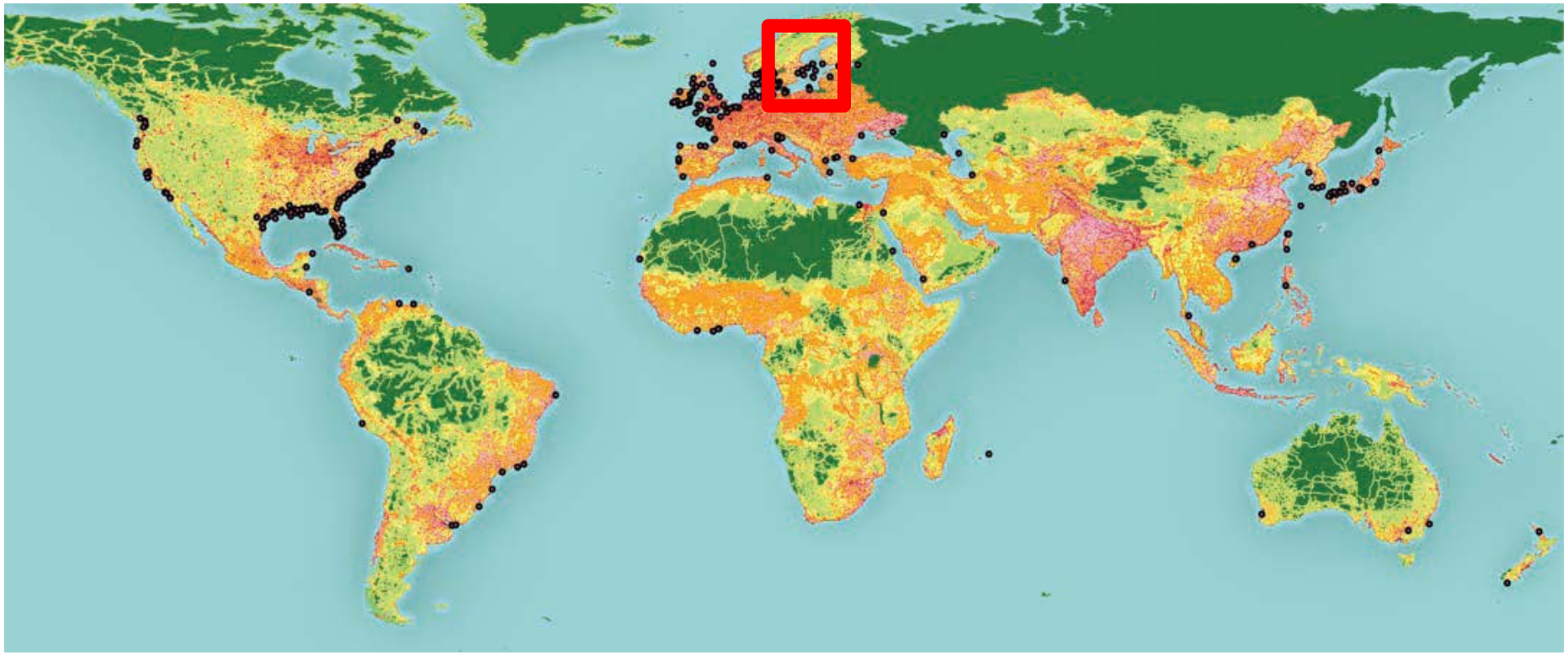


Eutrophication-associated dead coastal zones

(Source: Diaz and Rosenberg, 2008)



Eutrophication-associated dead coastal zones

(Source: Diaz and Rosenberg, 2008)

Baltic Sea - where are we now?

Large Cyanobacterial blooms

Baltic Sea - where are we now?

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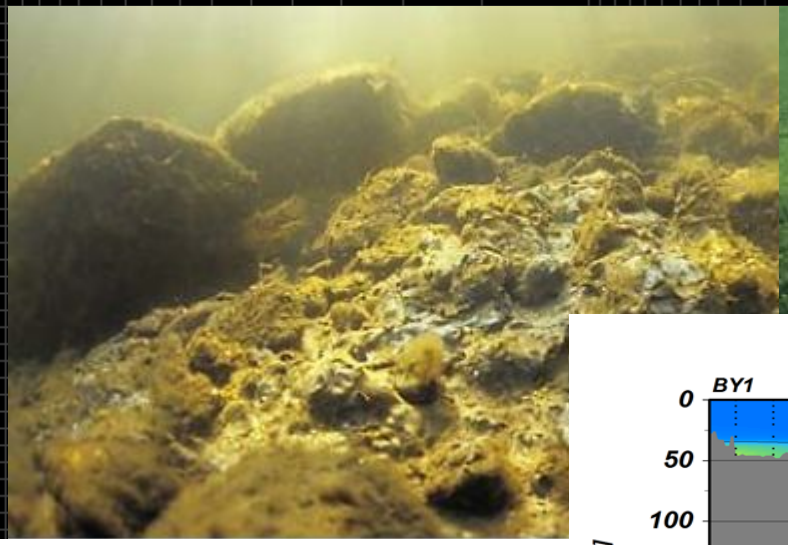

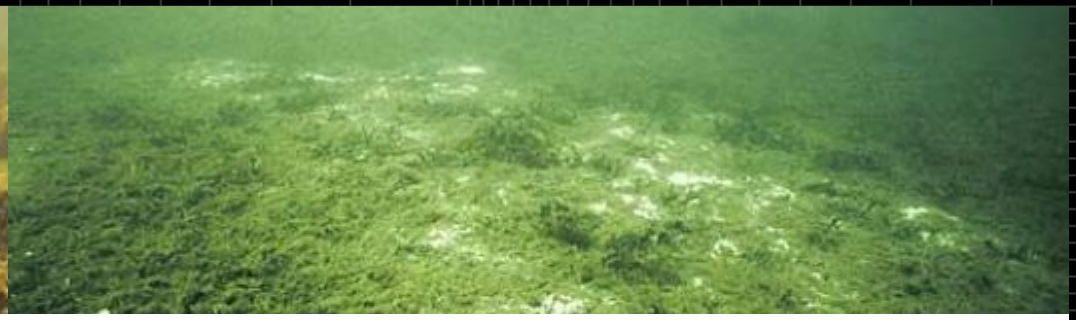

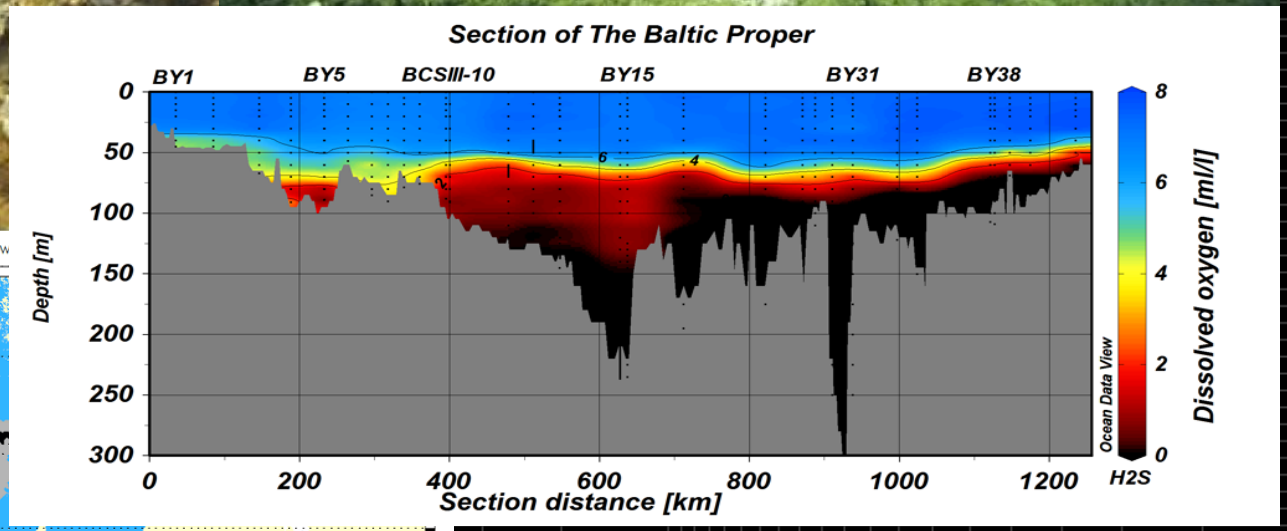

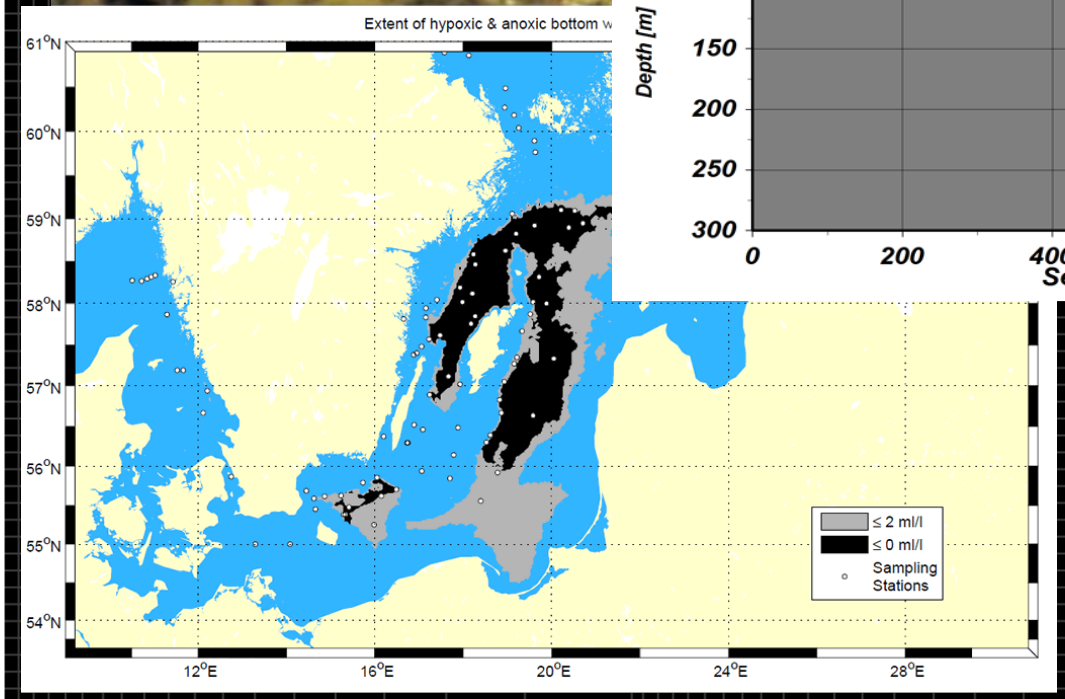

Hypoxia/anoxia

4 times as large today compared to 100 years ago

Baltic Sea - where are we now?

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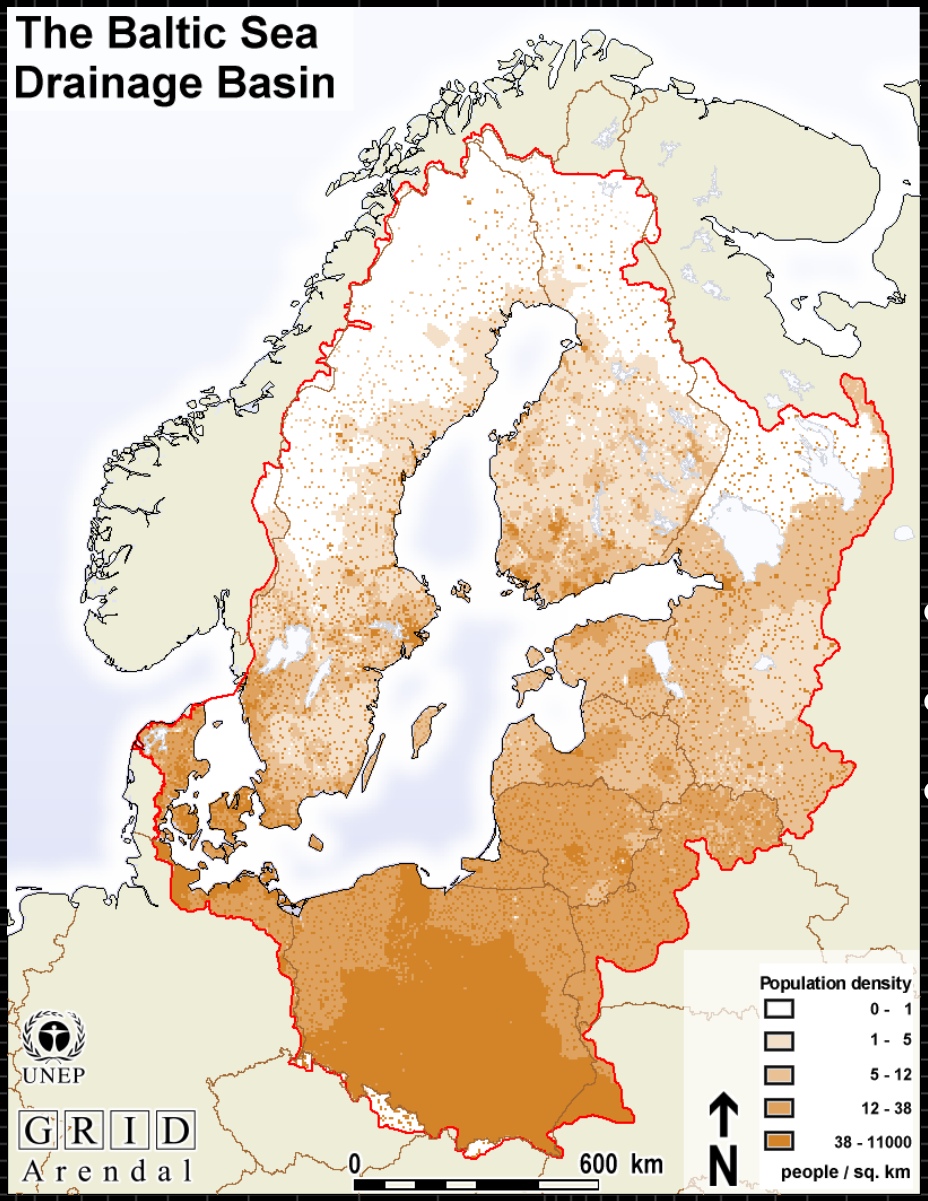

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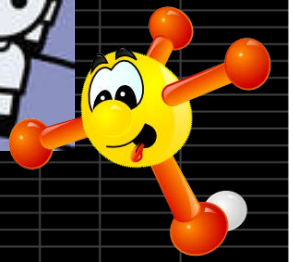

- Huge catchment area
- 85 million people
- Freshwater supply 15,000 m s^{-1}

Baltic Sea; how to approach the future?

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ECO SUPPORT

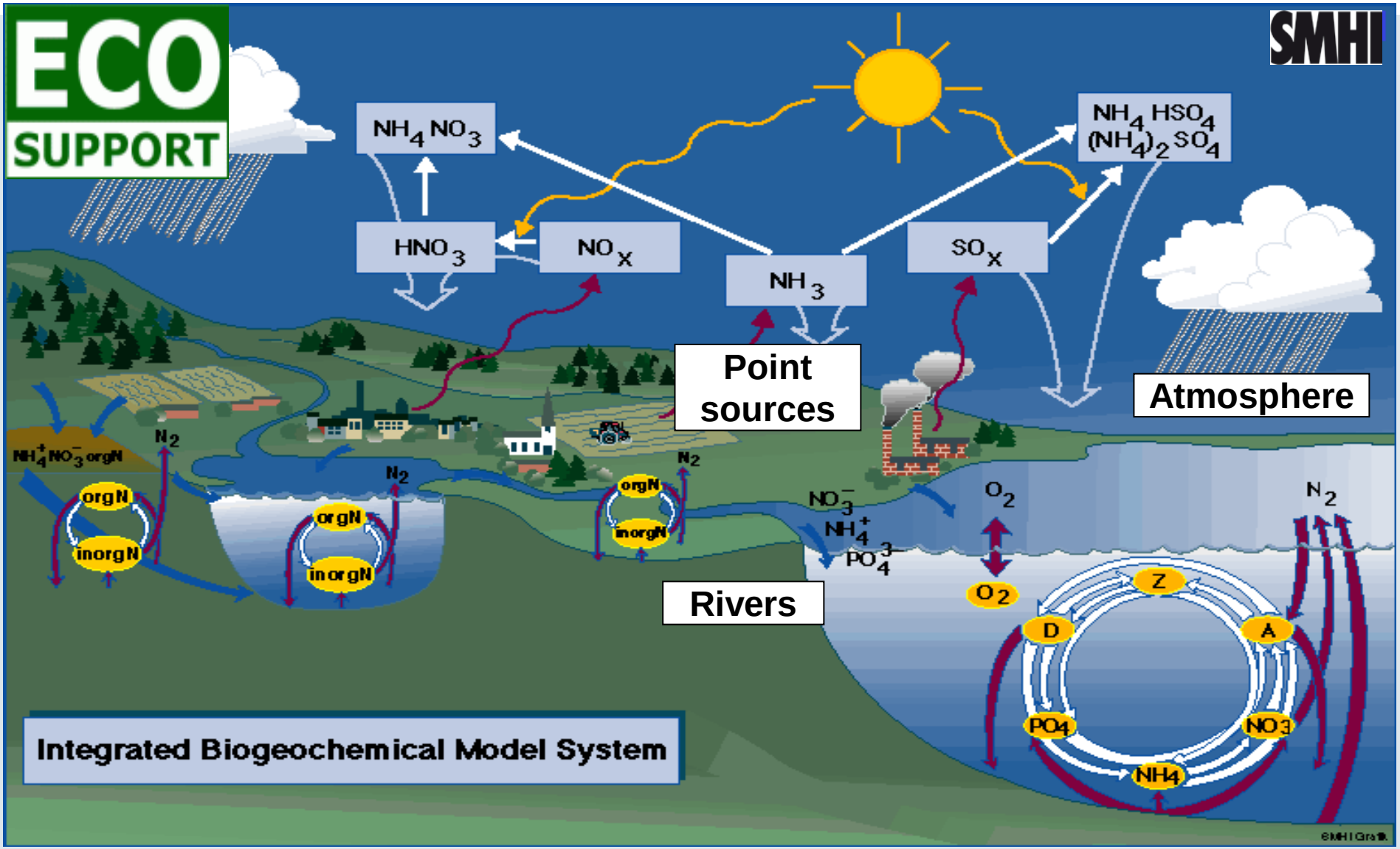
Combined effects of climate change and nutrient loads

Ensemble modeling to quantify uncertainty

Decision support to policy makers

IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO UNEP

Coupled climate - environmental modeling



Baltic Sea; how to approach the future?

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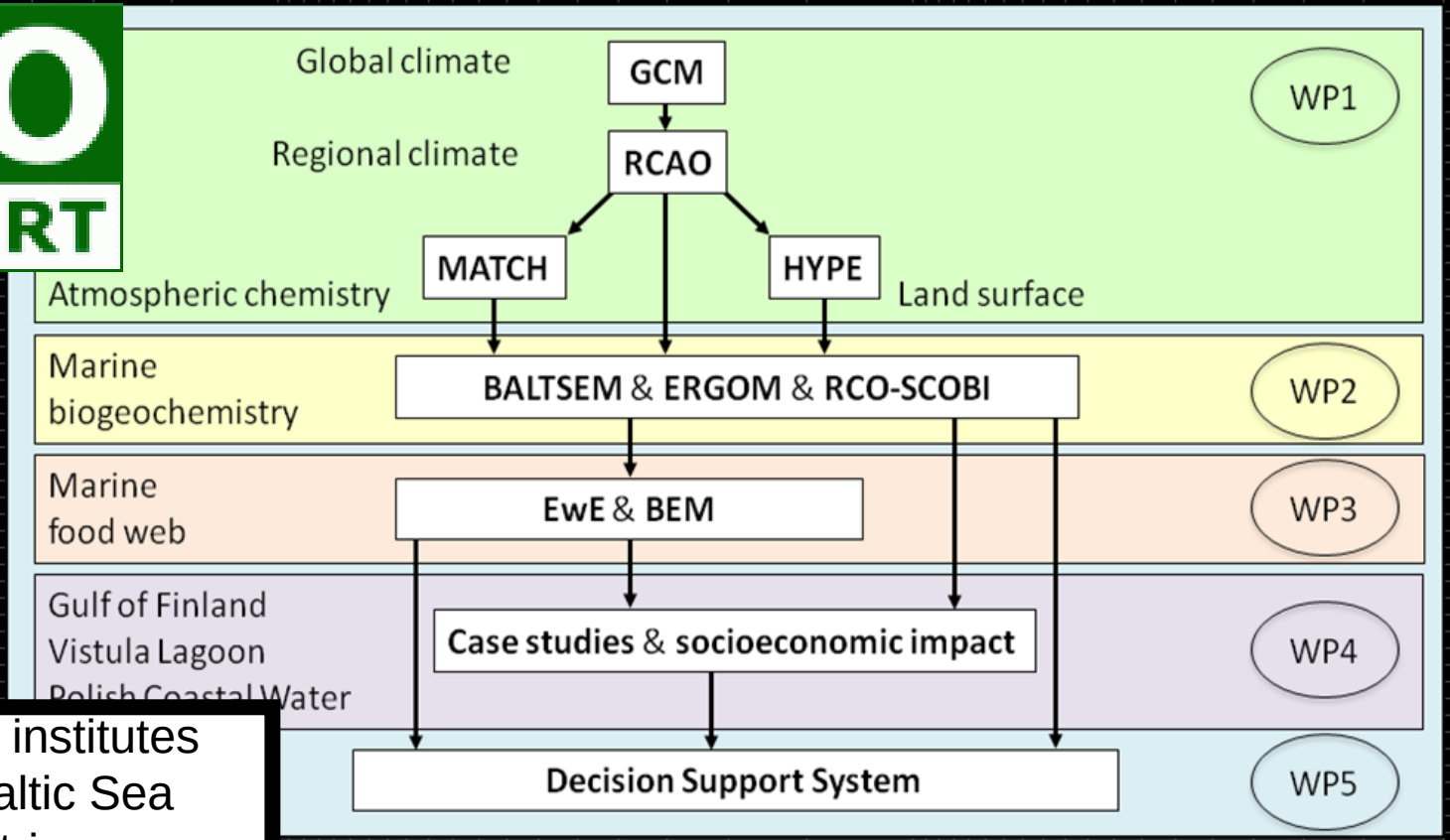
Advanced modeling tool for scenarios of the Baltic Sea ECOsystem to SUPPORT decision making

ECO SUPPORT



11 partner institutes from 7 Baltic Sea countries 2009-2011

formas

Forskningsrådet Formas

Formas främjar framstående forskning för hållbar utveckling

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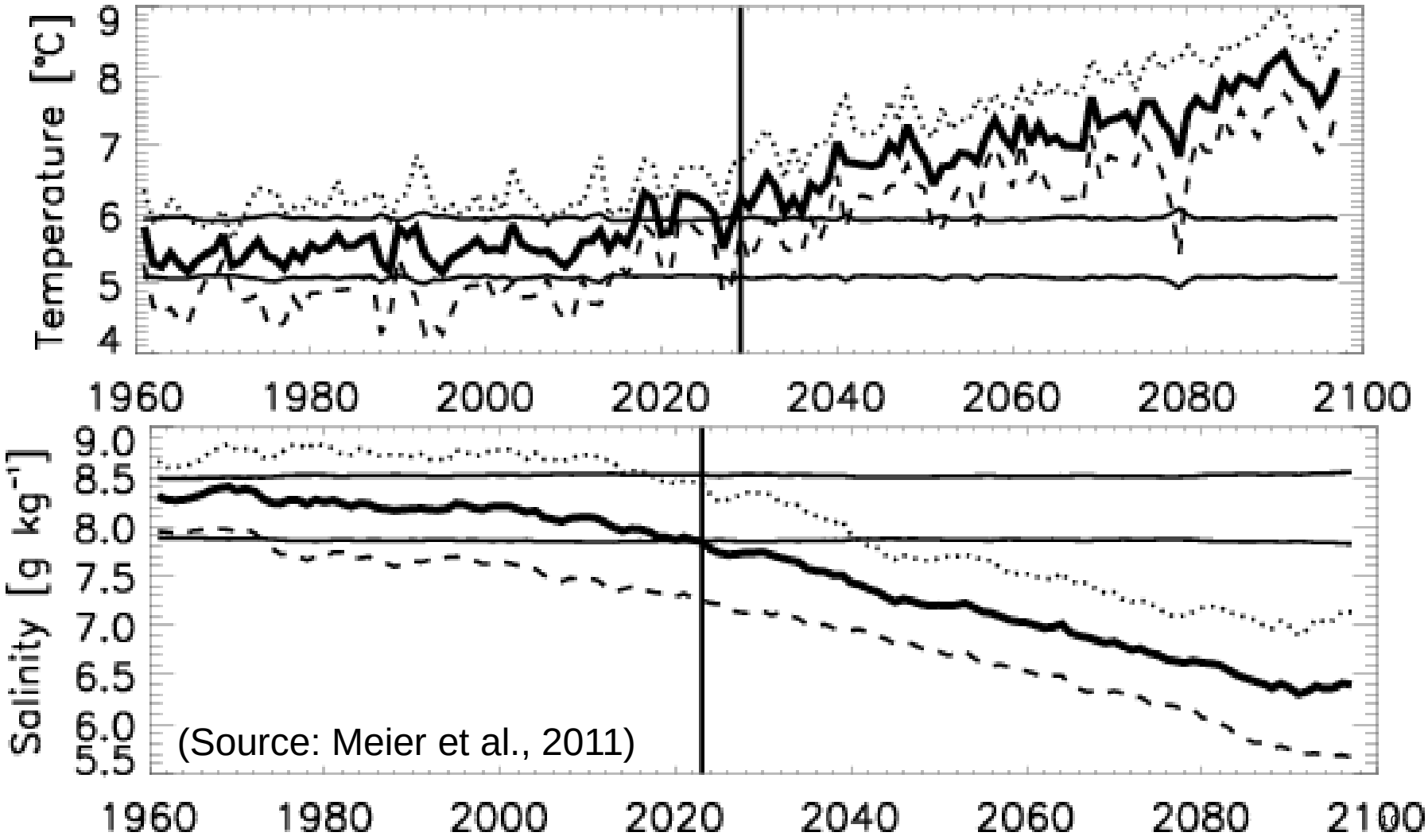
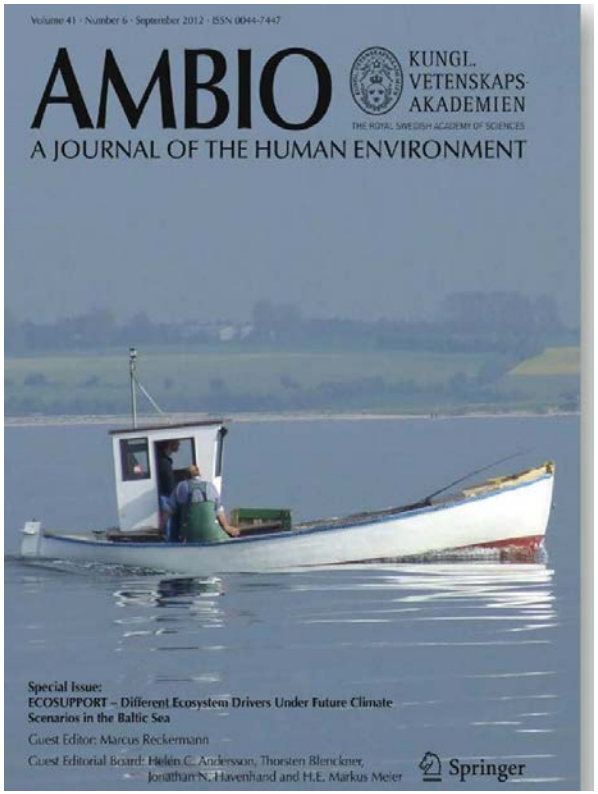
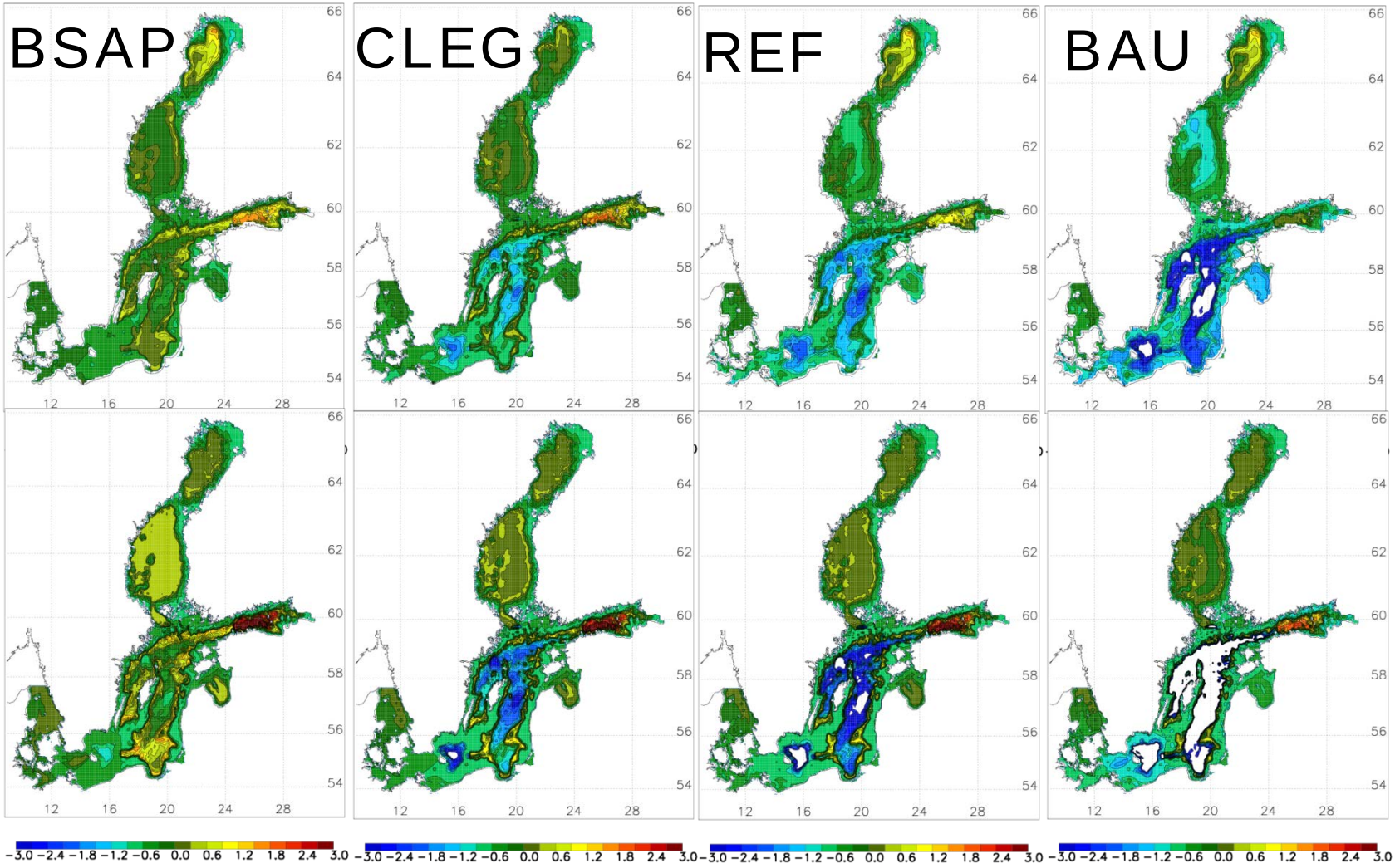
Ensemble mean volume averaged temperature and salinity



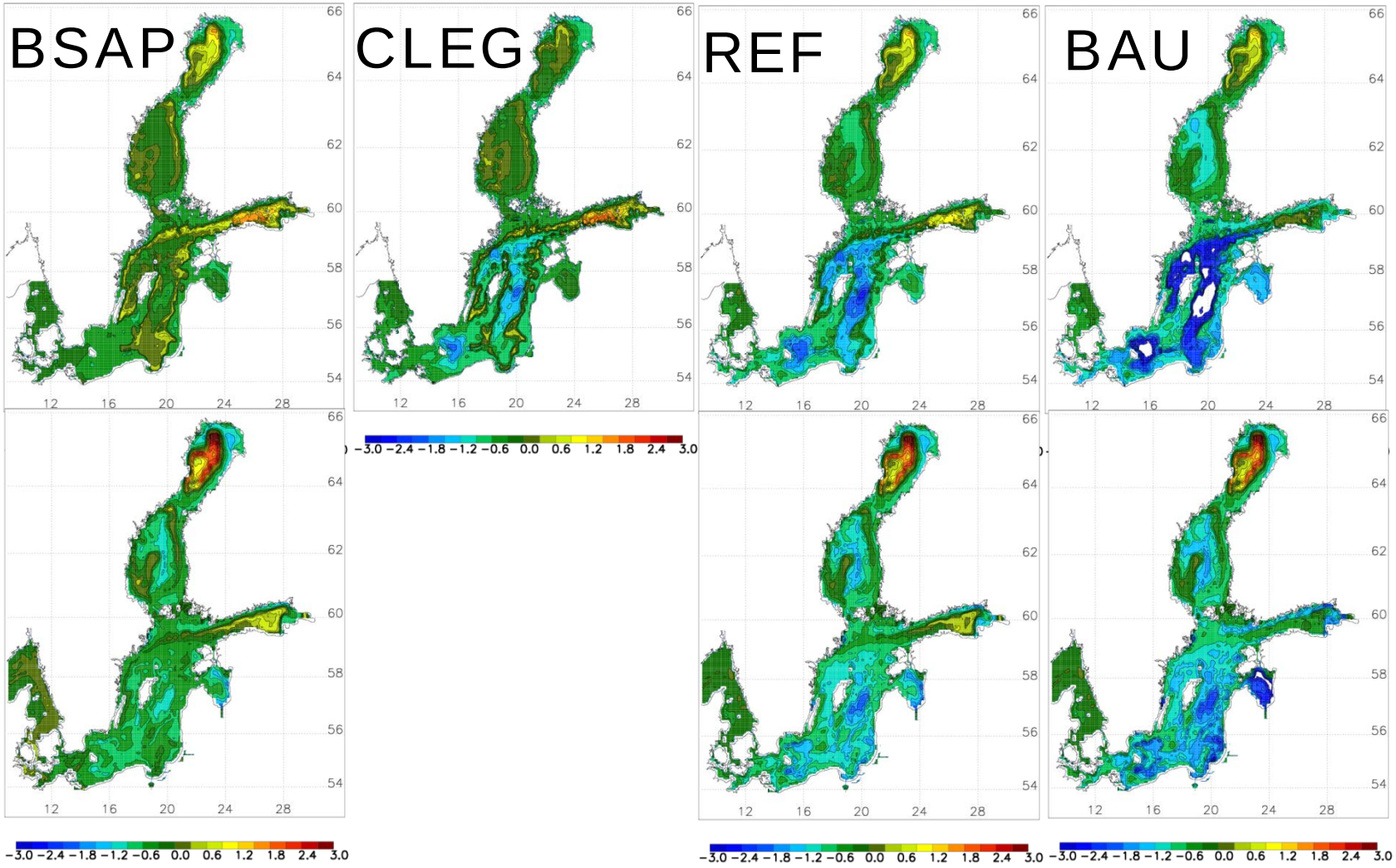
Results of the ECOSUPPORT project (e.g. AMBIO special issue, September 2012)



Ensemble (upper) and BALTSEM (lower) mean summer bottom oxygen concentration changes between 2070-2099 relative to 1978-2007



Ensemble (upper) and ERGOM (lower) mean summer bottom oxygen concentration changes between 2070-2099 relative to 1978-2007



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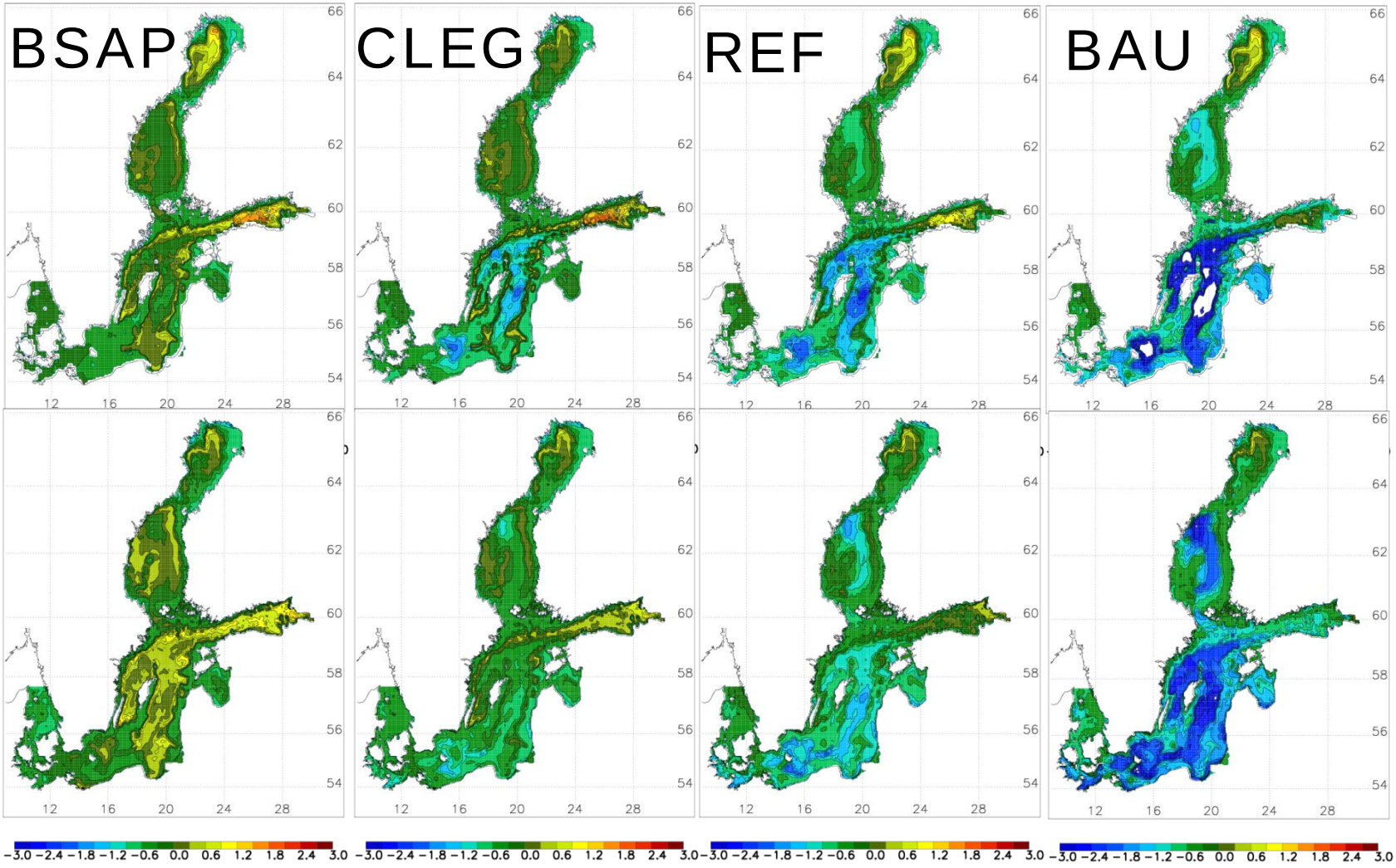
Ensemble (upper) and RCO-SCOBI (lower) mean summer bottom oxygen concentration changes between 2070-2099 relative to 1978-2007



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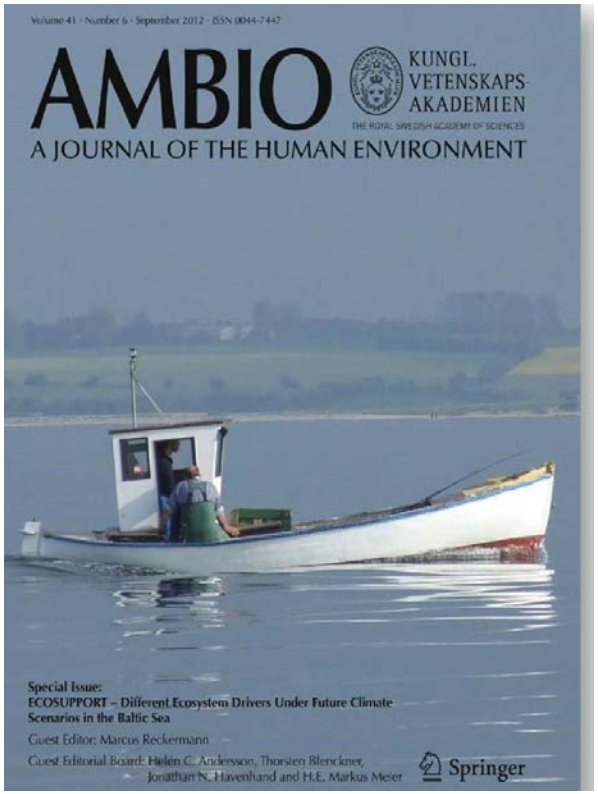

Evaluation of Climate
System Responses ?

Reconstruction of the past since 1850

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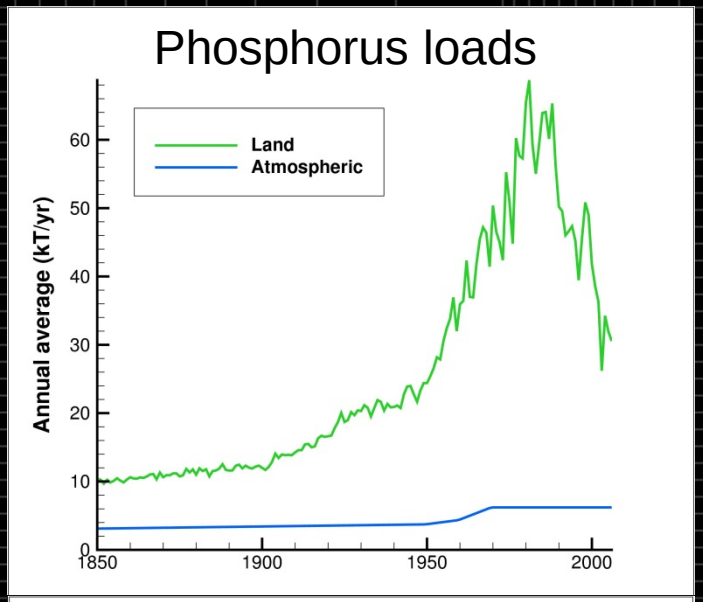
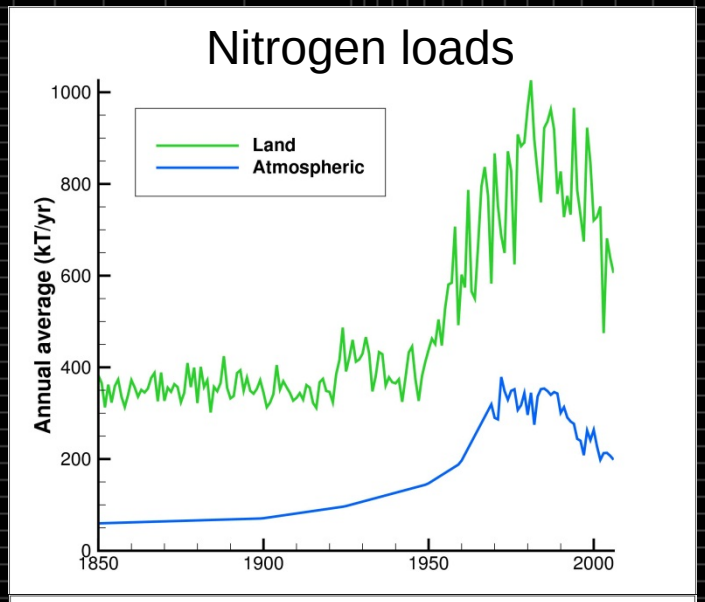
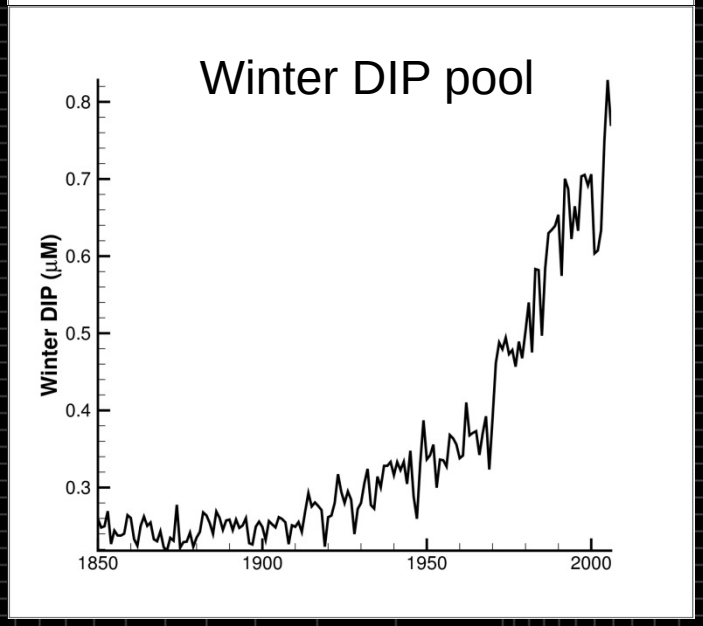
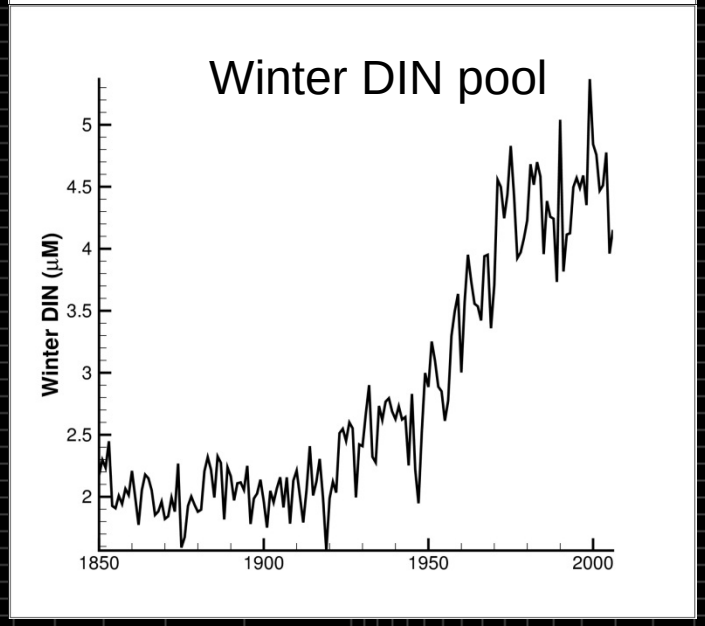


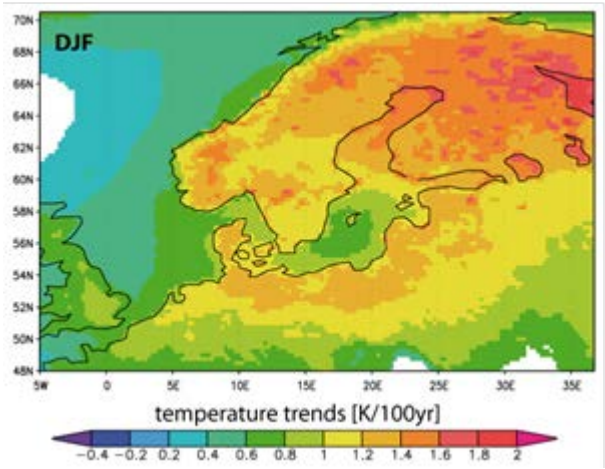




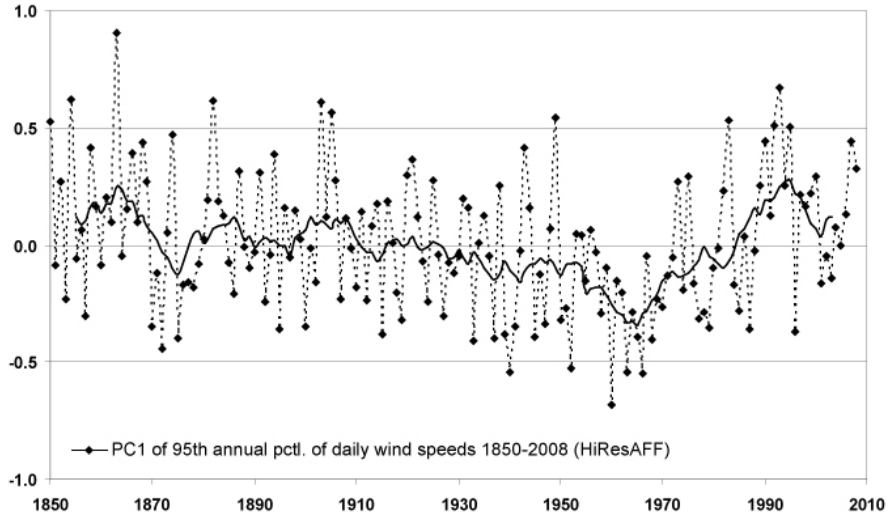


(Source: Gustafsson et al., 2012)

HiResAFF (Schenk and Zorita 2012, Climate of the Past) 1850-2009



Seasonal near-surface temperature trends in winter 1850-2009 (HiResAFF). Non-significant trends (p<0.05) in white.



Time series of the first Principal Component (PC1) of the 95th annual percentile of daily wind speeds representing storminess over Northern Europe in the period 1850-2008 (HiResAFF).

(Source: Meier et al., 2012, ERL)

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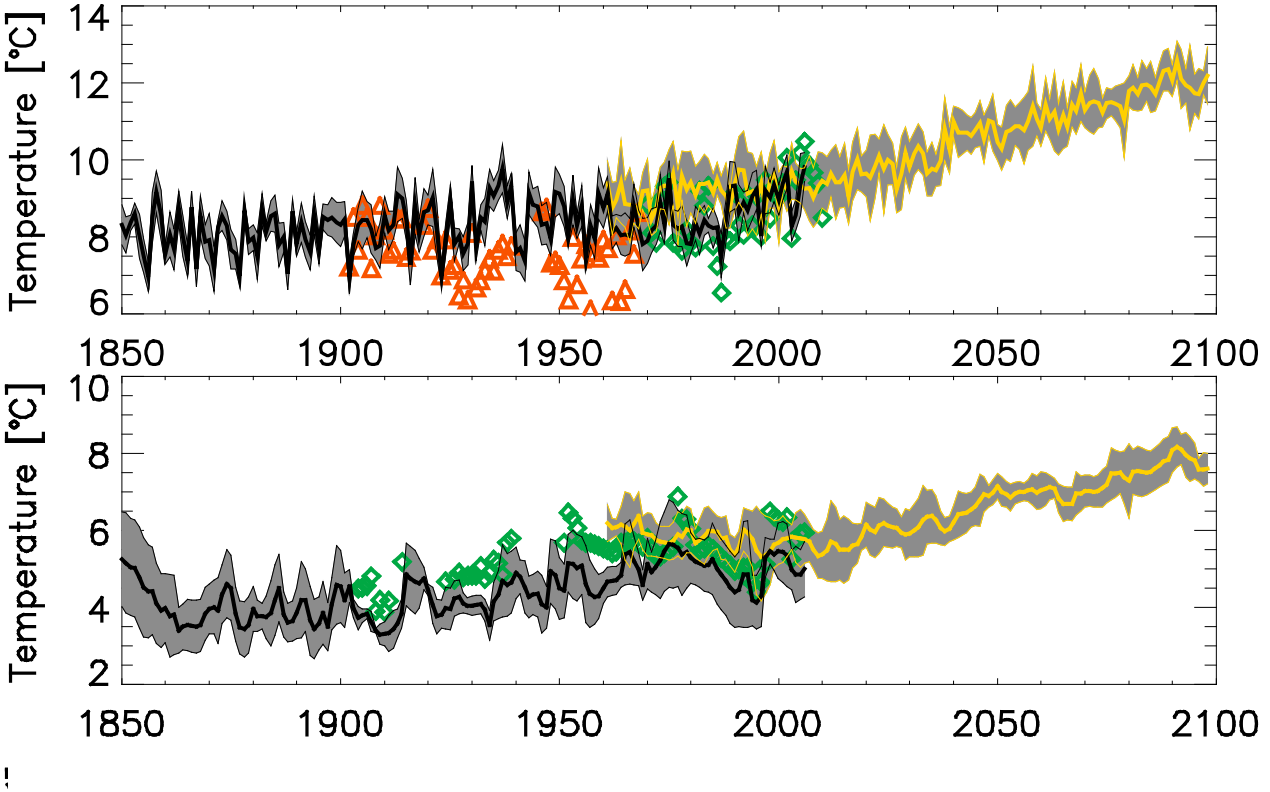
Simulated ensemble averages and observed annual mean water temperatures ((a), (b)) and salinities ((c), (d)) at Gotland Deep at 1.5 and 200 m depth, annual mean oxygen concentrations at 200 m depth (e), and winter (January–March) mean surface phosphate (f) and nitrate (g) concentrations. Shaded areas 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.



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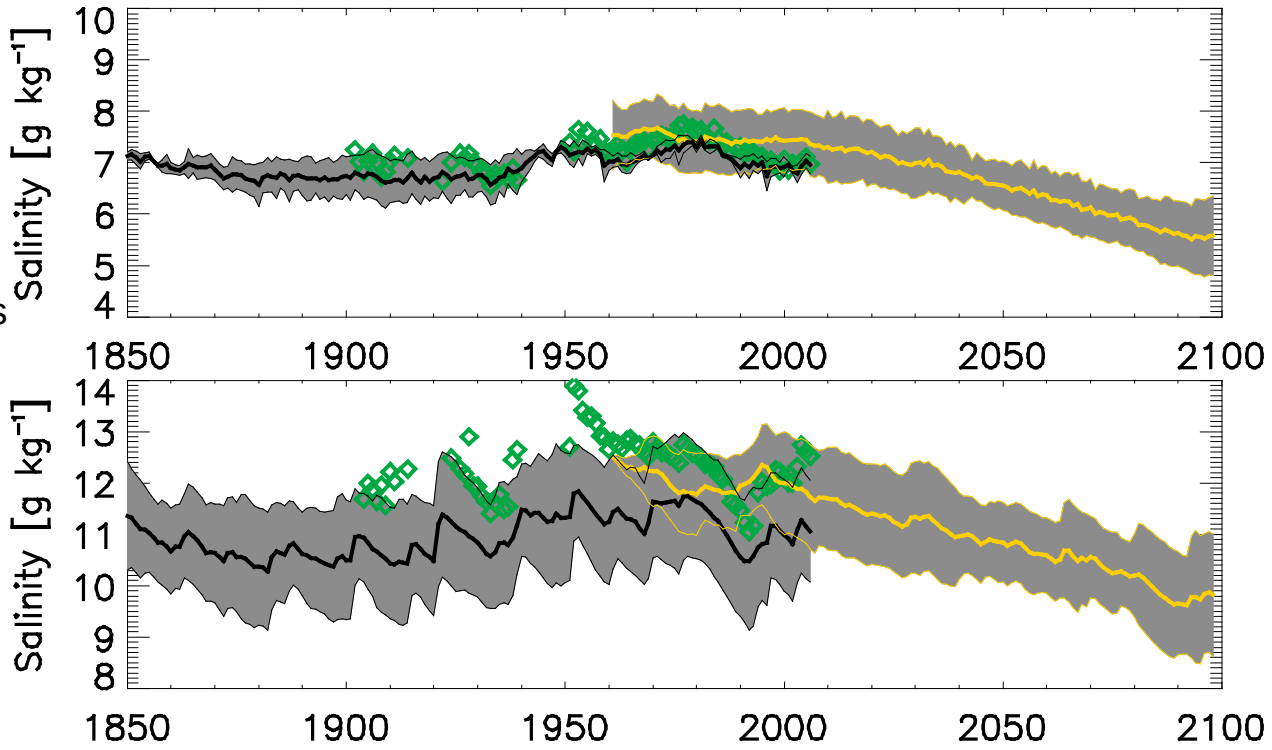

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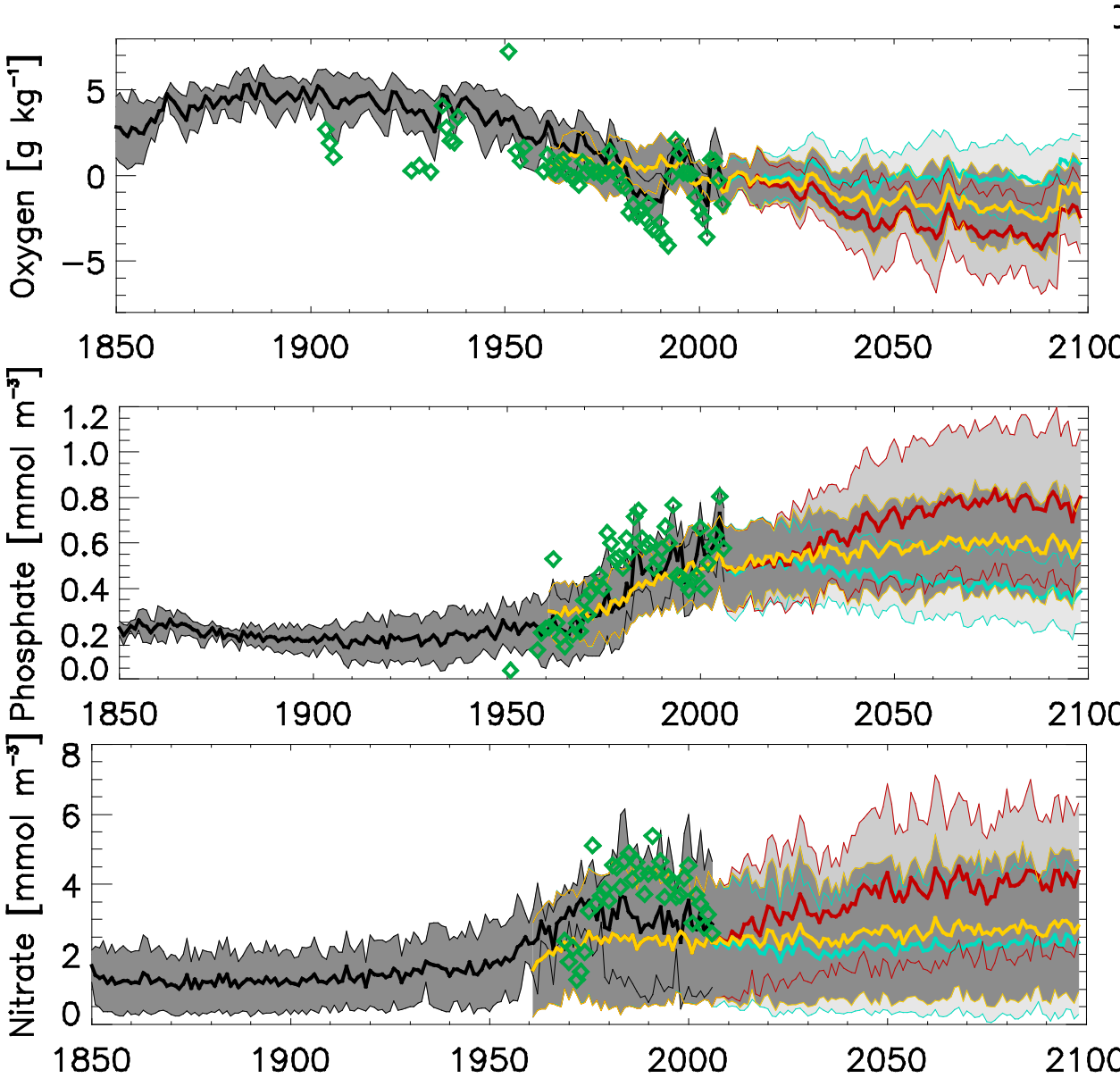

Conclusions

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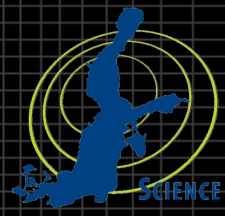
- **Reconstructions of past climate variability help to constrain the sensitivity of biogeochemical models to nutrient load changes**
- **Projections suggest unprecedented changes in the future ecosystem despite large uncertainties due to unknown nutrient loads, biases of the GCMs, biases of the biogeochemical models and natural variability**



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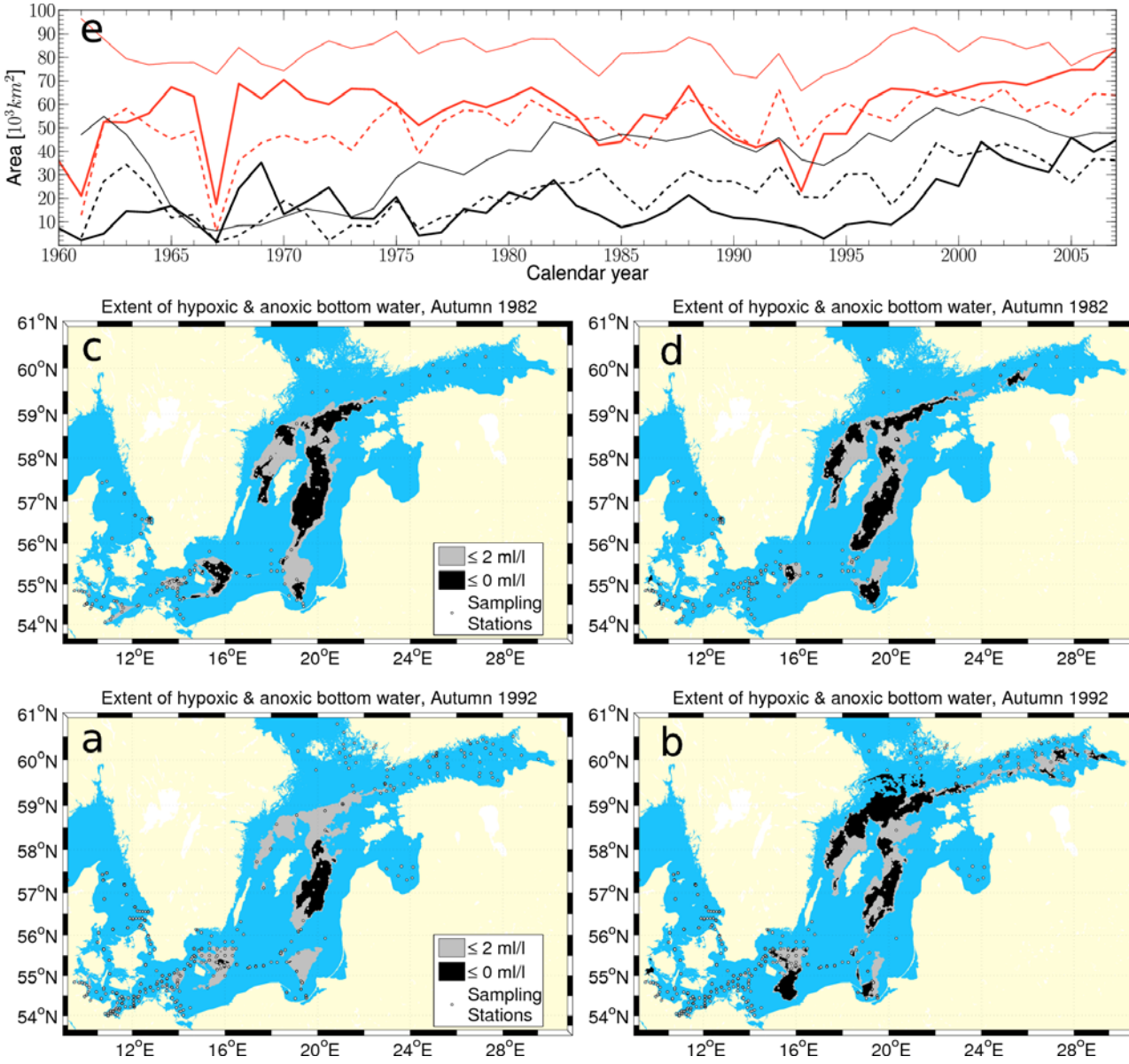
ECO SUPPORT

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

(Source: Väli et al., 2013)




Thank you for your attention