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Modelling the extent of hypoxia and anoxia in the Baltic Sea for the period 1970-2010

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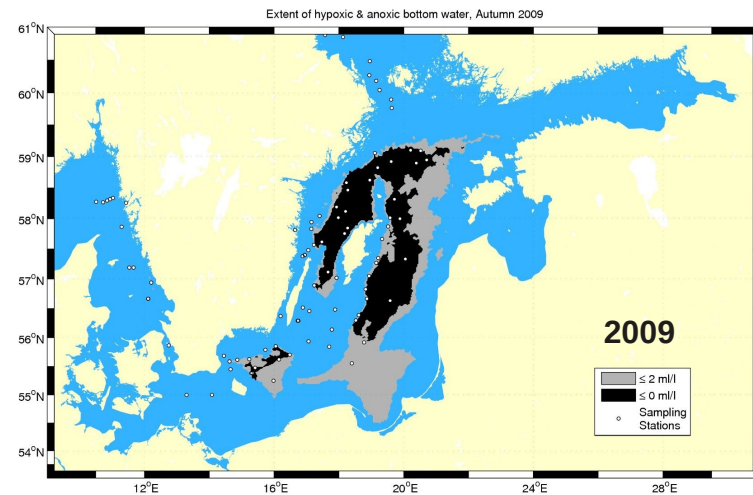
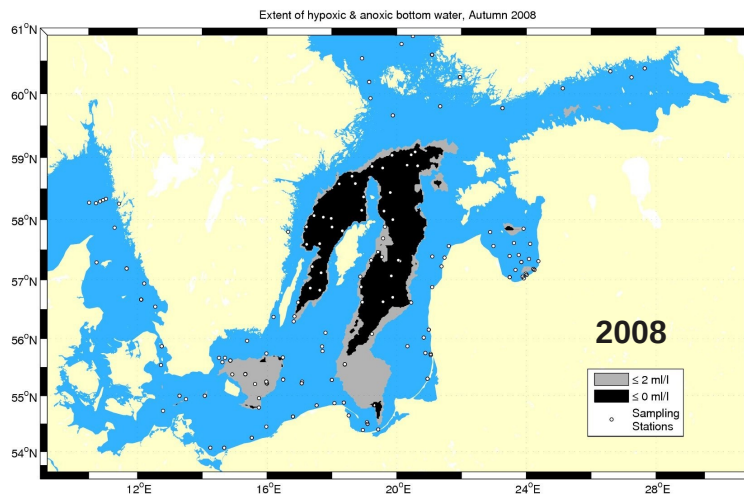
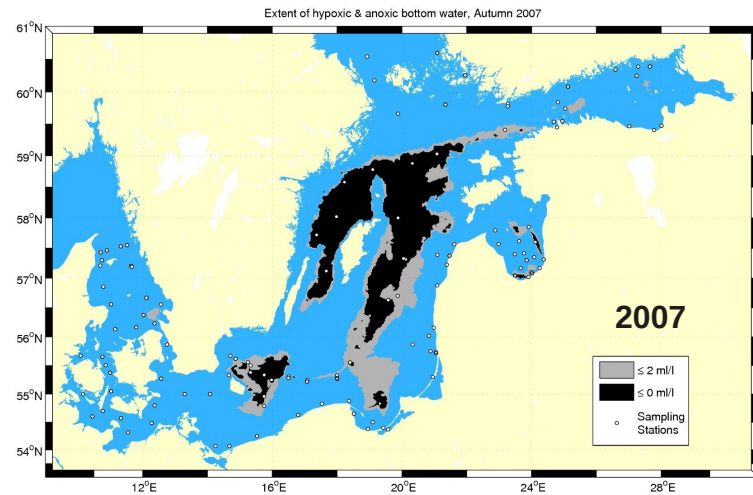
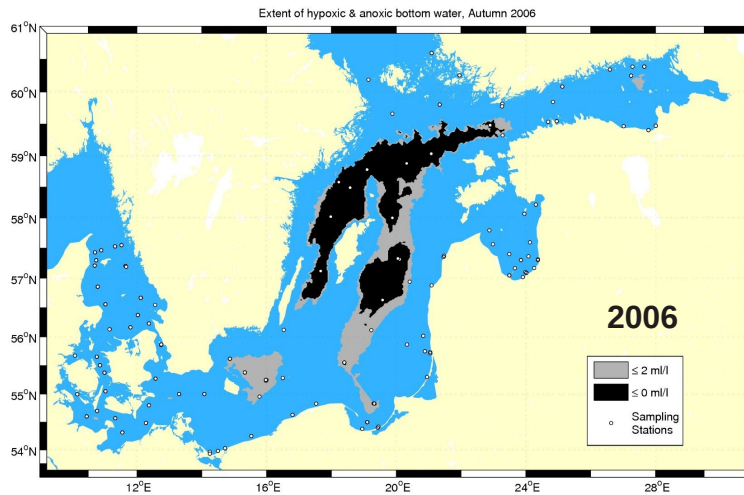
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Motivation

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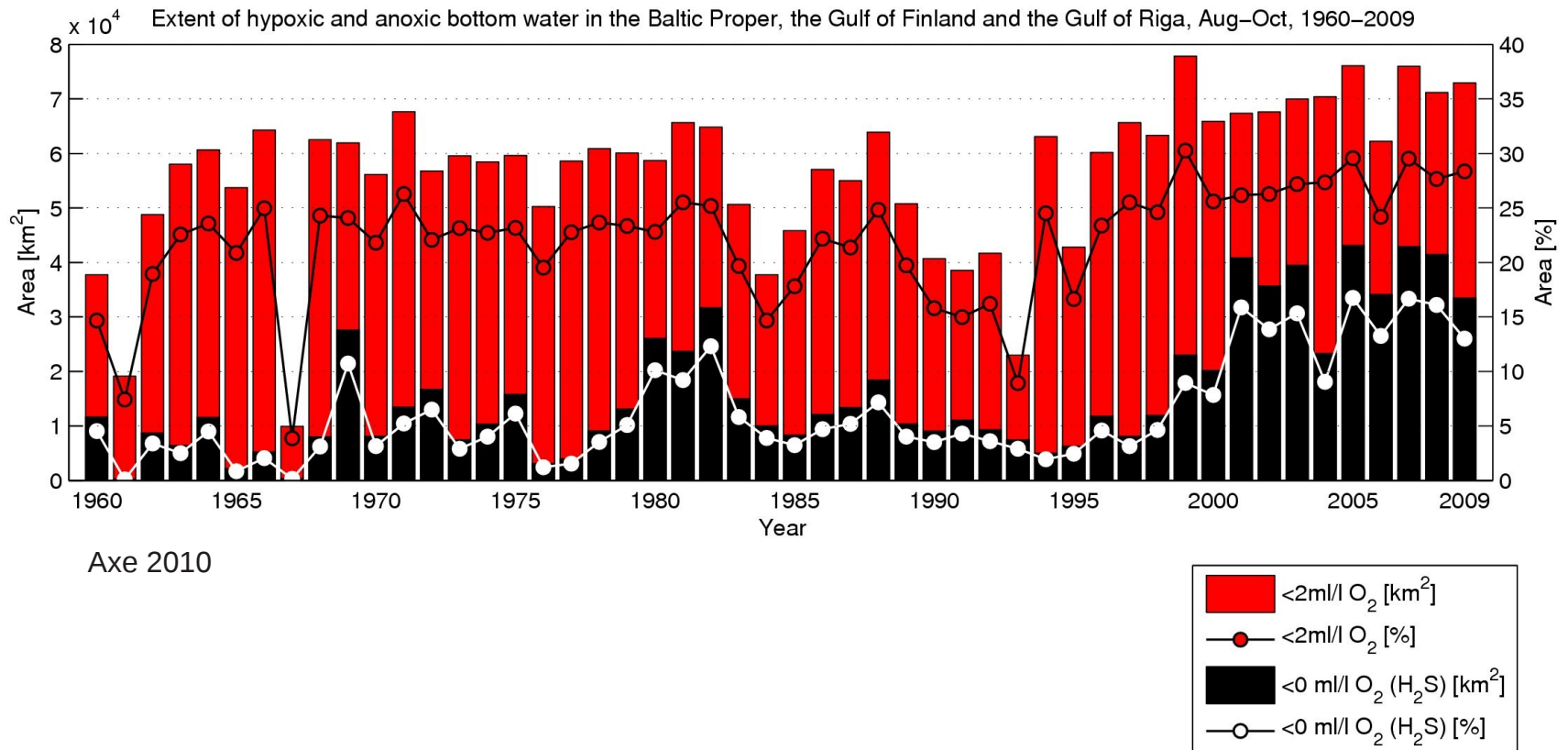
Extent of hypoxic & anoxic bottom water



Axe 2010

Motivation

Extent of hypoxic & anoxic bottom water



Motivation

Extent of hypoxic & anoxic bottom water

- the detailed distribution and evolution of oxygenated, hypoxic and anoxic areas is required for studying oxygen related processes such as habitat utilisation of spawning fish, survival rates of their eggs and settlement probabilities of juveniles
- state of the art physical-biogeochemical models are of limited use because of:
 - ▶ uncertainties in the models (e.g. 16 state variables, Daewel & Schrum 2013)
 - ▶ uncertainties in forcing functions
 - ▶ inaccurate nutrient inputs or initial conditions
 - ▶ Coupling between nutrient cycles and oxygen conditions at the bottom
 - ▶ expensive to run

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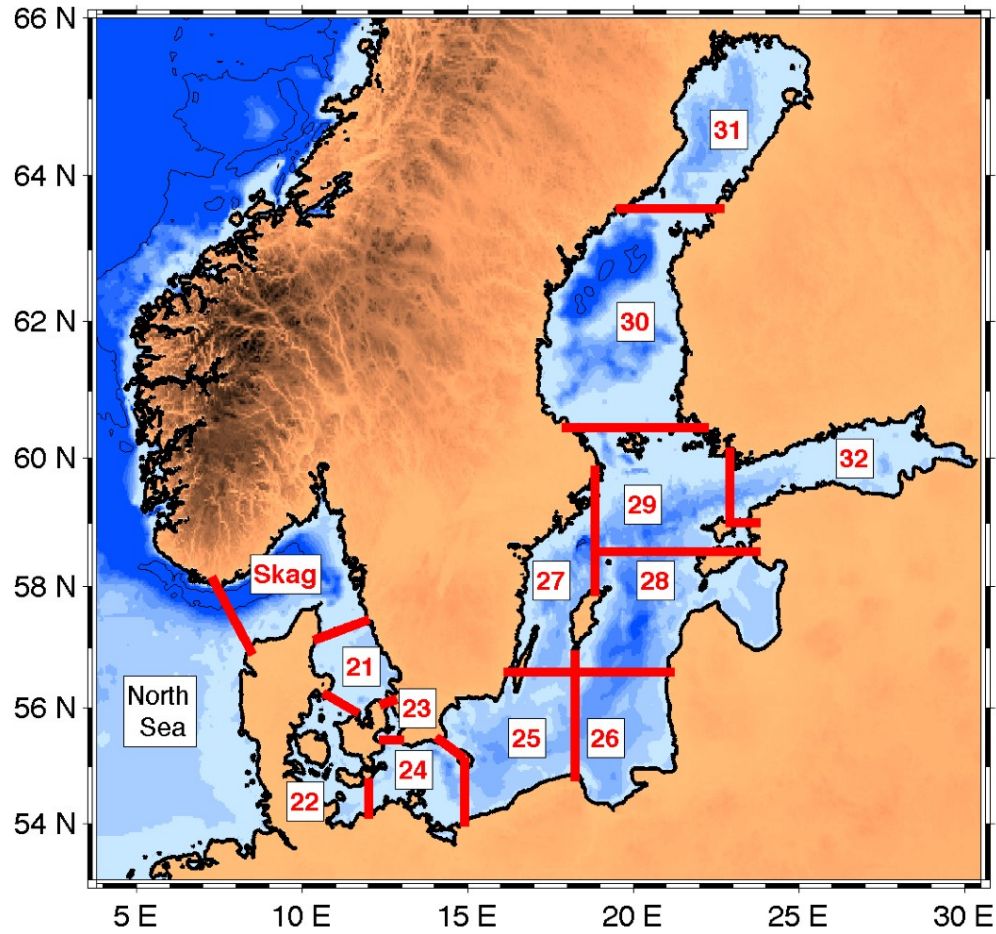
Methods

Hydrodynamic & oxygen consumption model

- BSIOM - 3D coupled sea ice-ocean model of the Baltic Sea (Lehmann & Hinrichsen 2000)
 - ▶ Horizontal resolution 2.5 km
 - ▶ 60 vertical levels
 - ▶ Model domain: Baltic Sea including Skagerrak & Kattegat
 - ▶ Forcing: river runoff (Kronsell & Andersson 2011), atmosphere SMHI (Lars Meuller pers. comm.)
 - ▶ Period 1970-2010
- OXYCON – Oxygen consumption model (Hansen & Bendtsen 2009; Jonasson et al. 2012)
 - ▶ Based on local carbon budget for North Sea – Baltic Sea transition area
 - ▶ One pelagic oxygen sink
 - ▶ Two benthic oxygen sinks
 - ▶ Adjusted oxygen consumption rates to annual mean primary production of the different sub-basins (Wasmund et al. 2001)

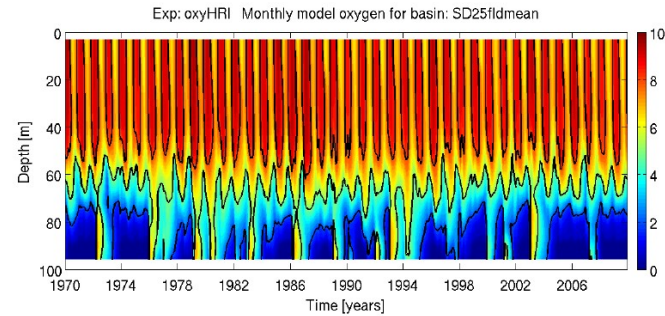
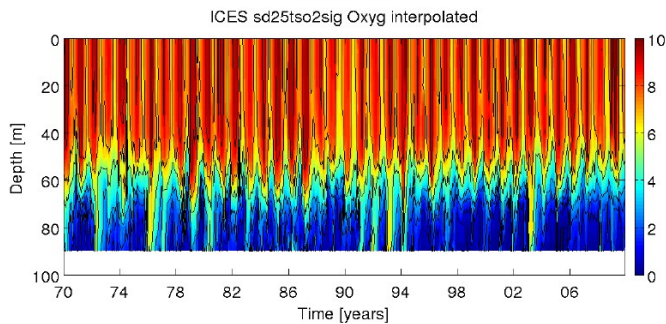
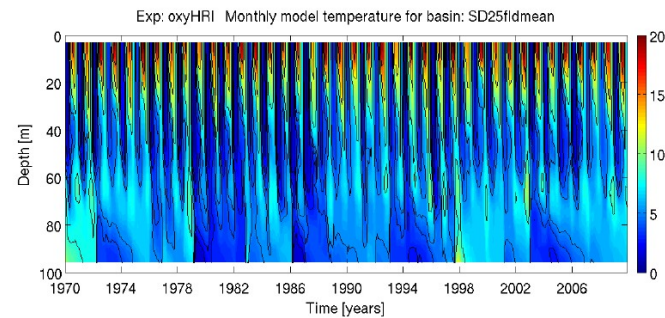
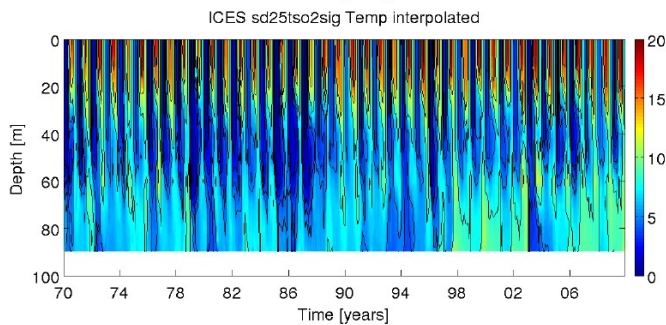
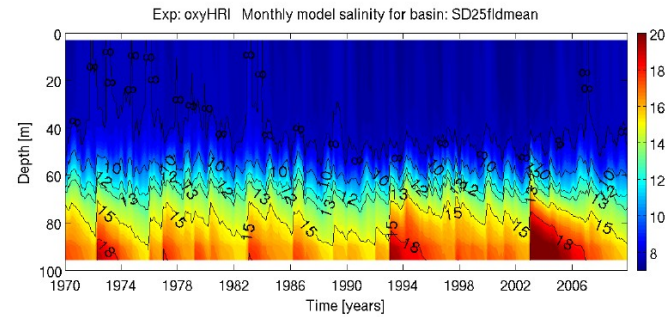
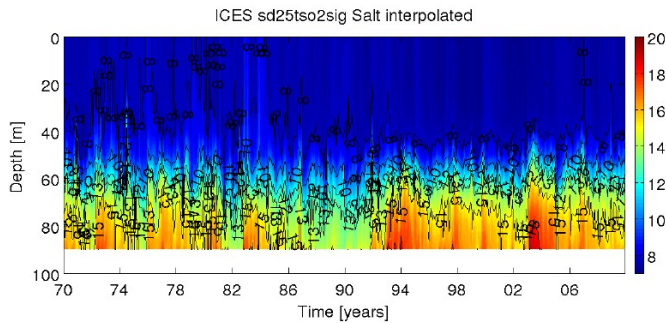
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Results



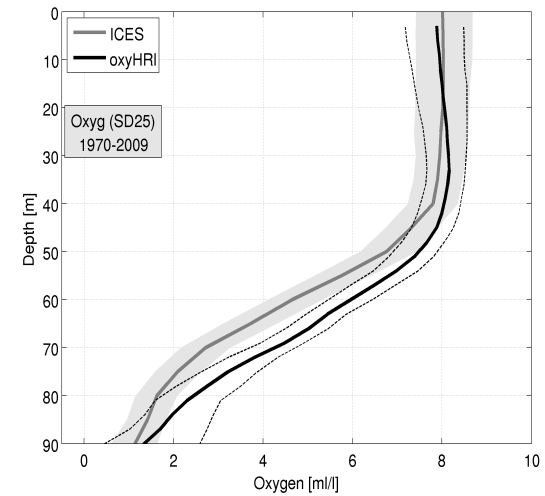
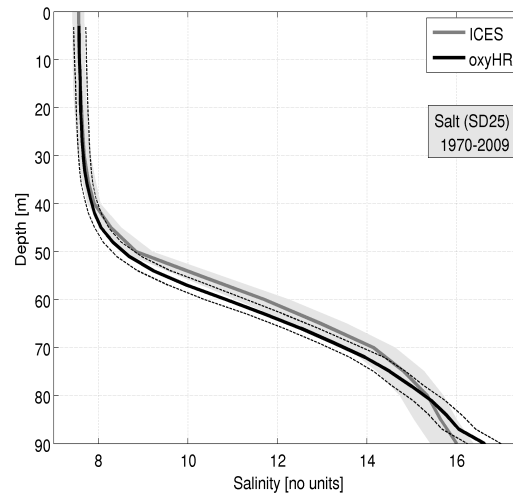
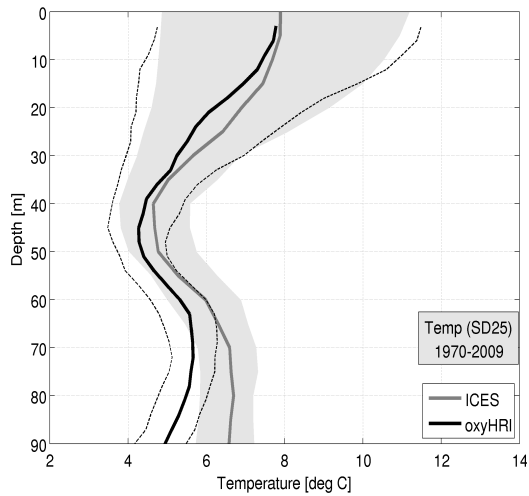
Results

SD 25 Bornholm Basin ICES - BSIOM

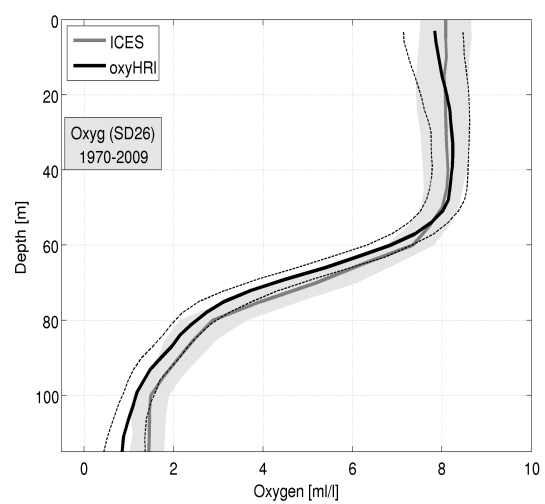
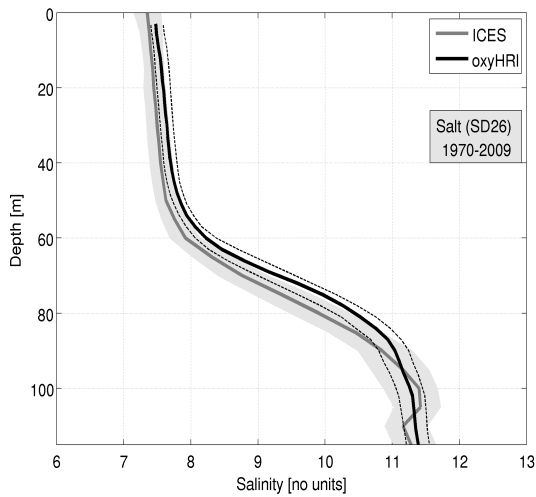
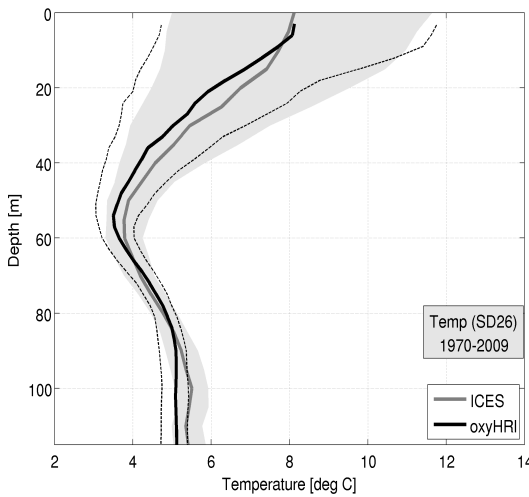


Results

Comparison ICES sub-divisions - BSIOM



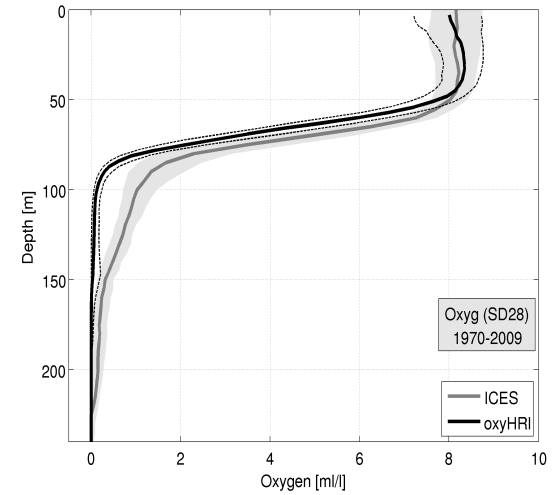
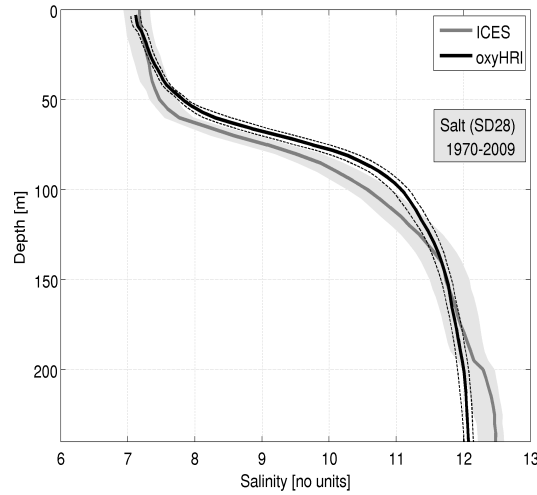
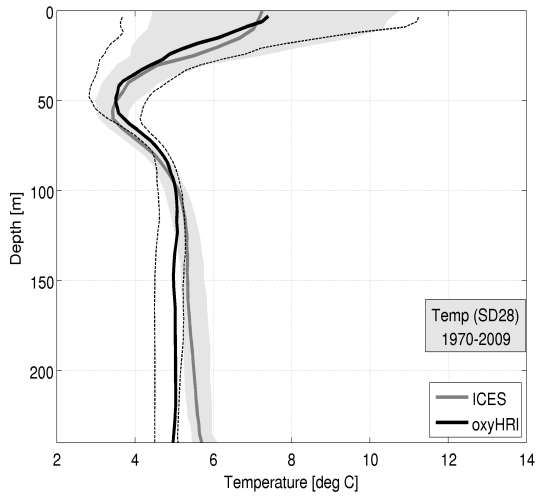
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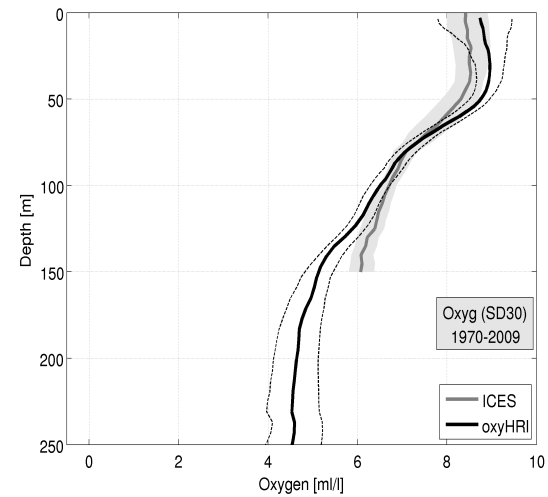
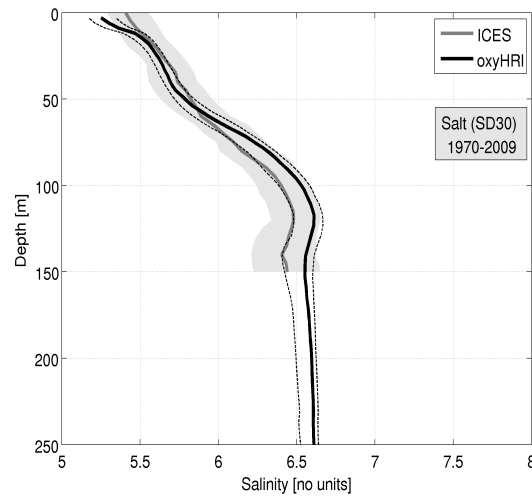
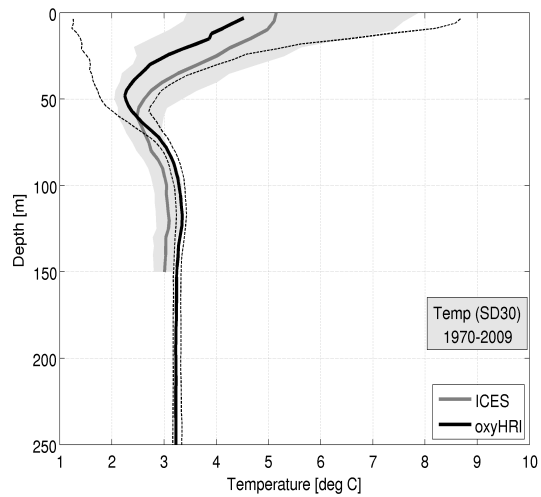
SD 26

Results

Comparison ICES sub-divisions - BSIOM



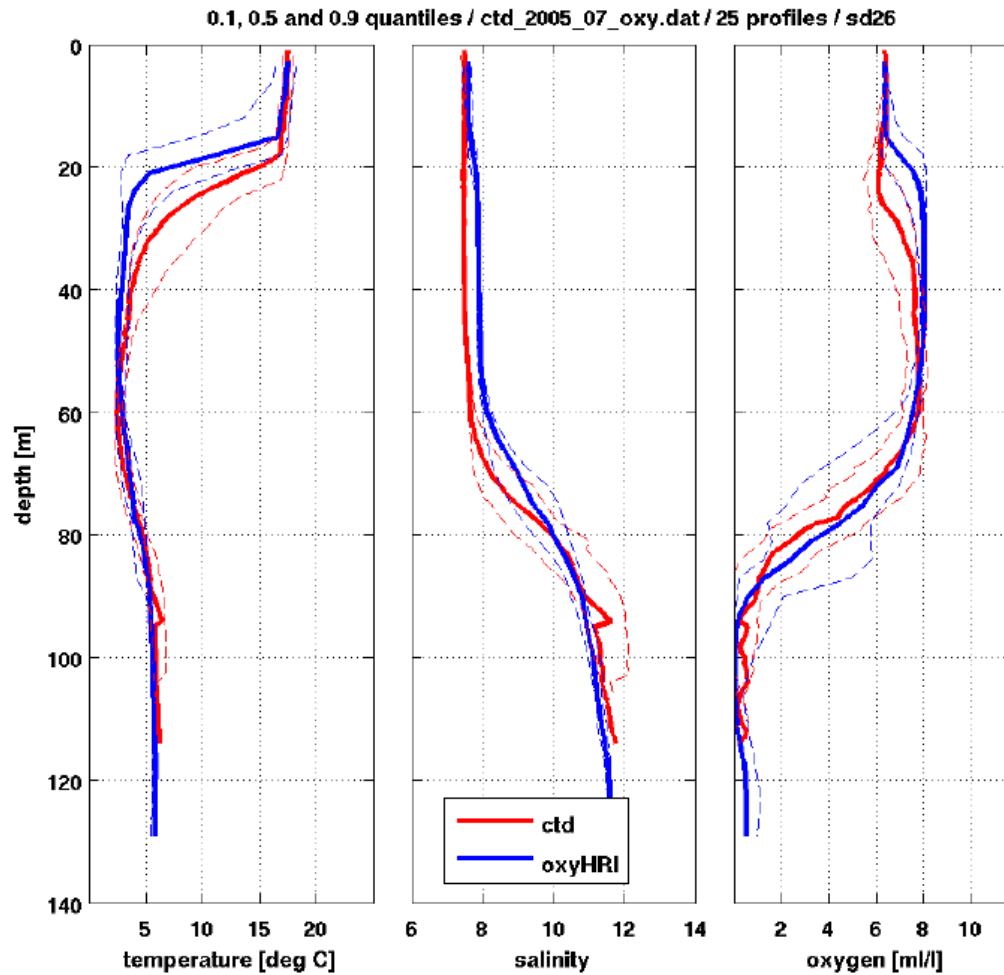
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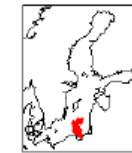
SD 30

Results

Comparison GEOMAR CTD - BSIOM

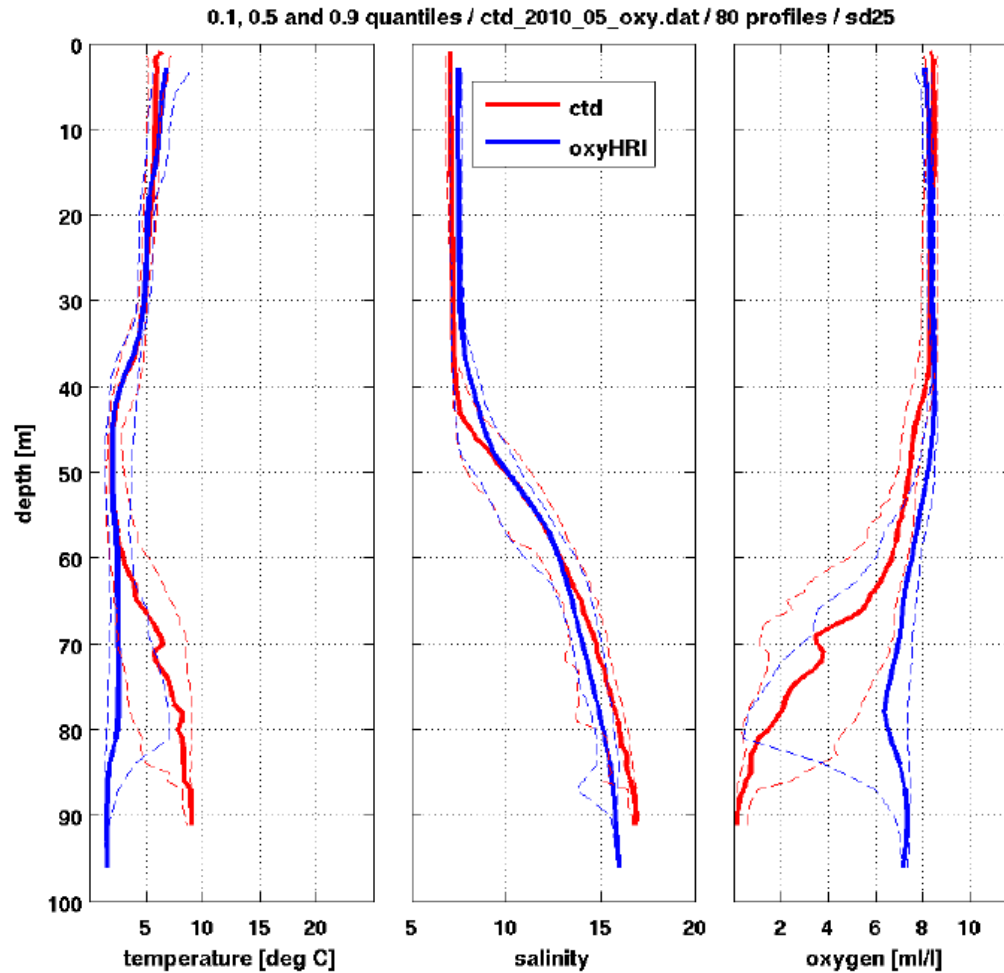


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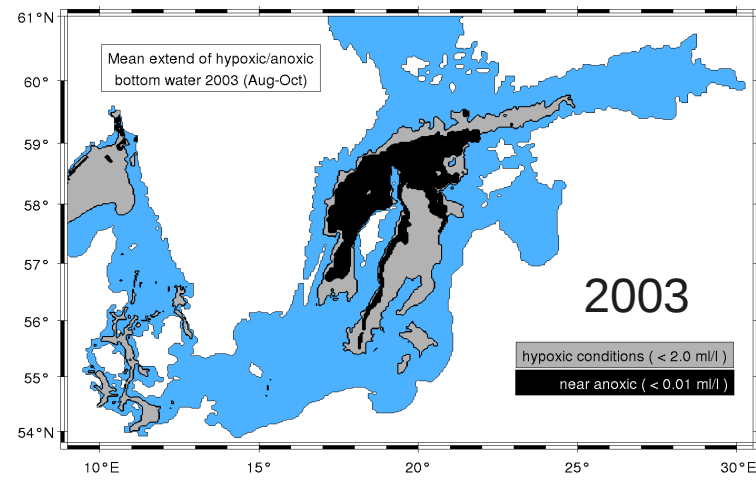
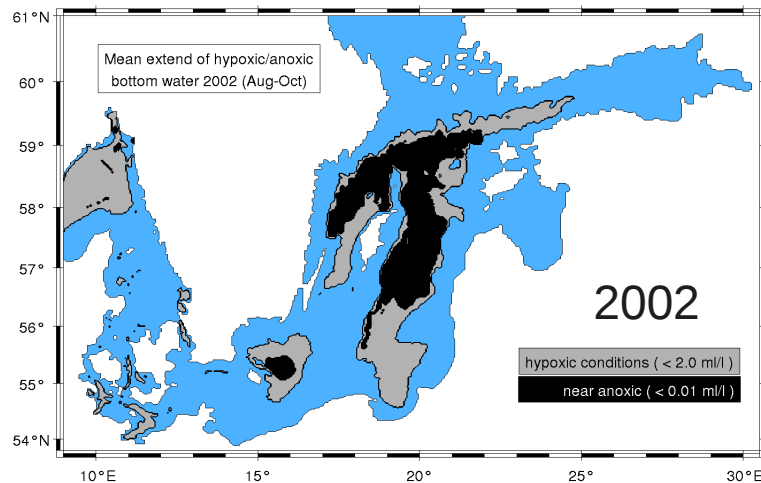
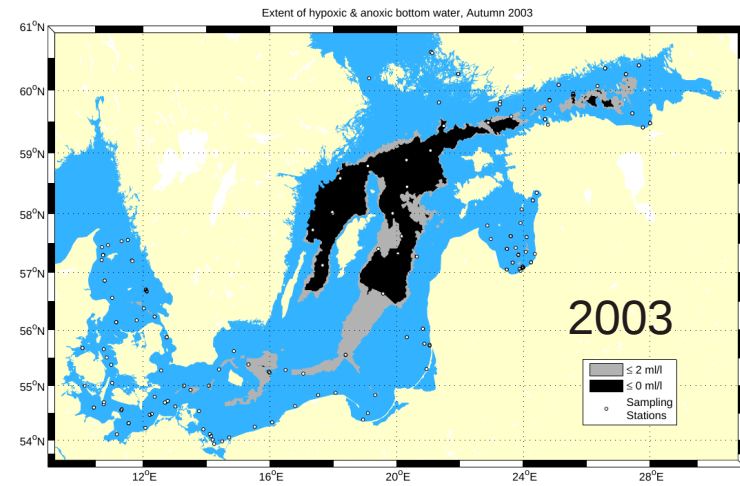
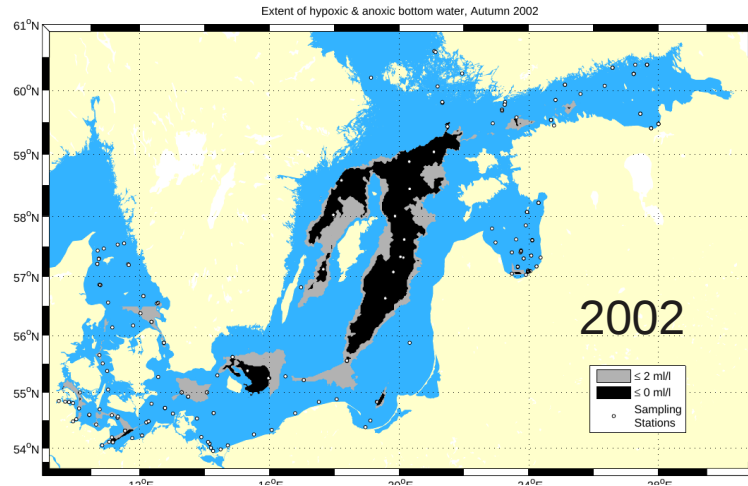


Results

Comparison GEOMAR CTD - BSIOM

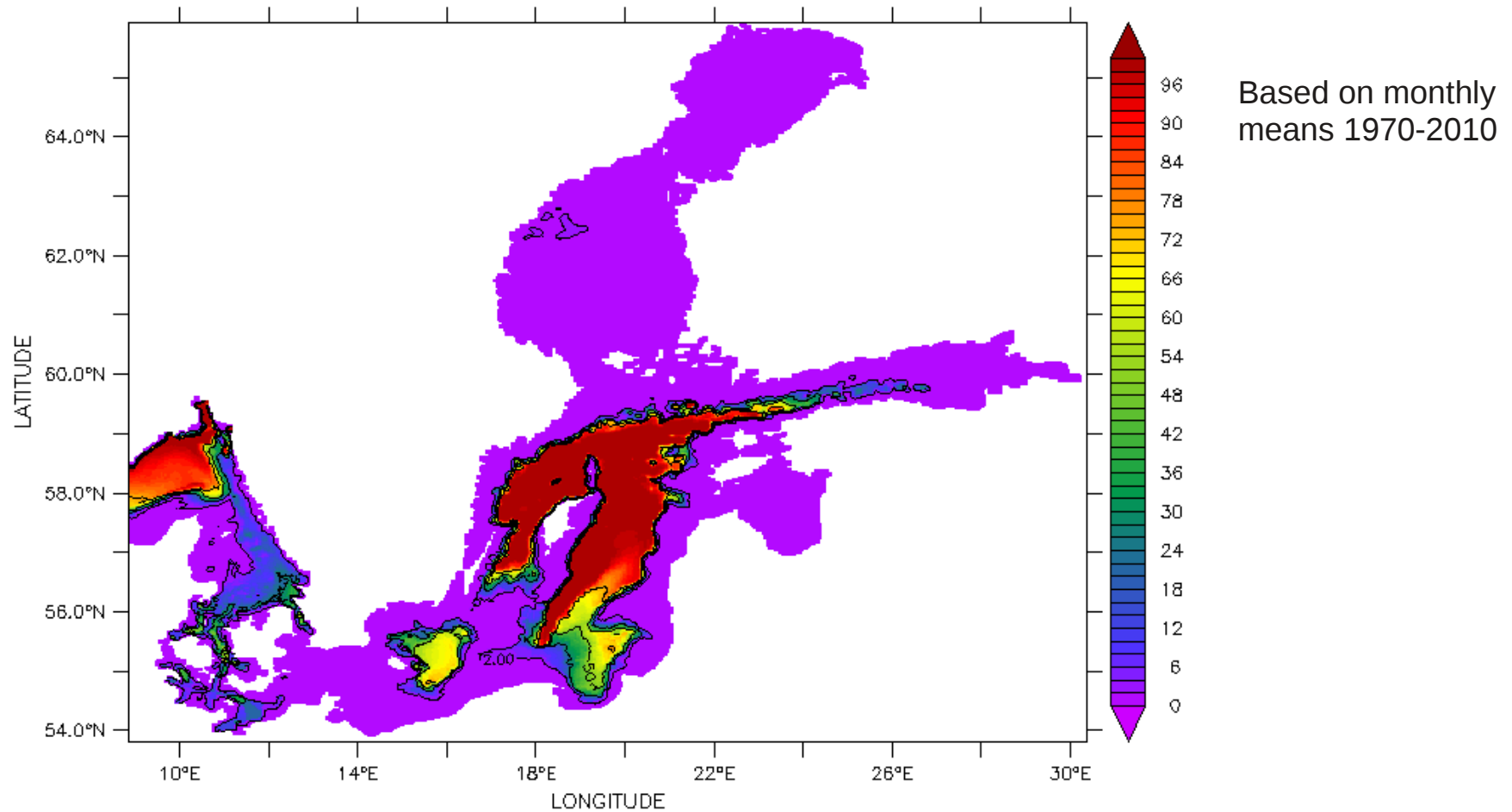


Results hypoxic (< 2ml/l) conditions 2002 & 2003



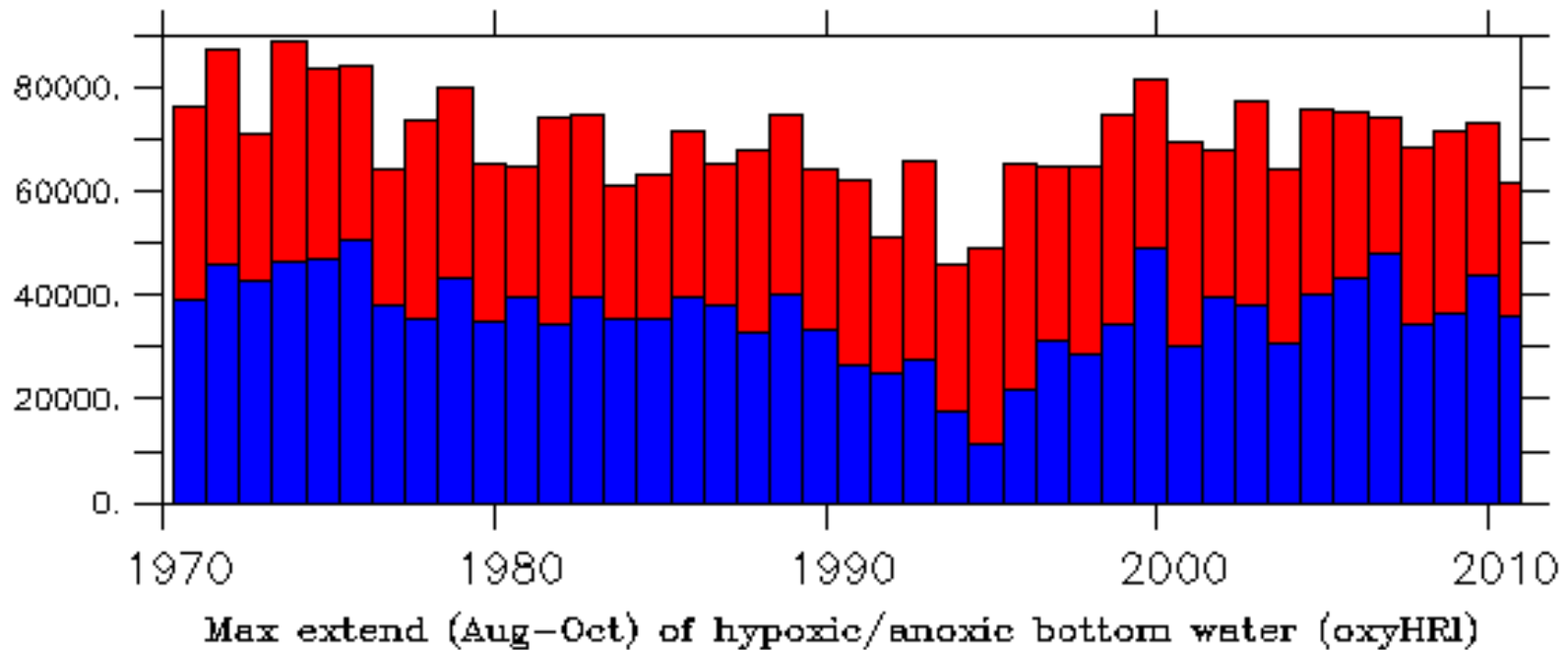
Results

Frequency of hypoxic (< 2ml/l) conditions



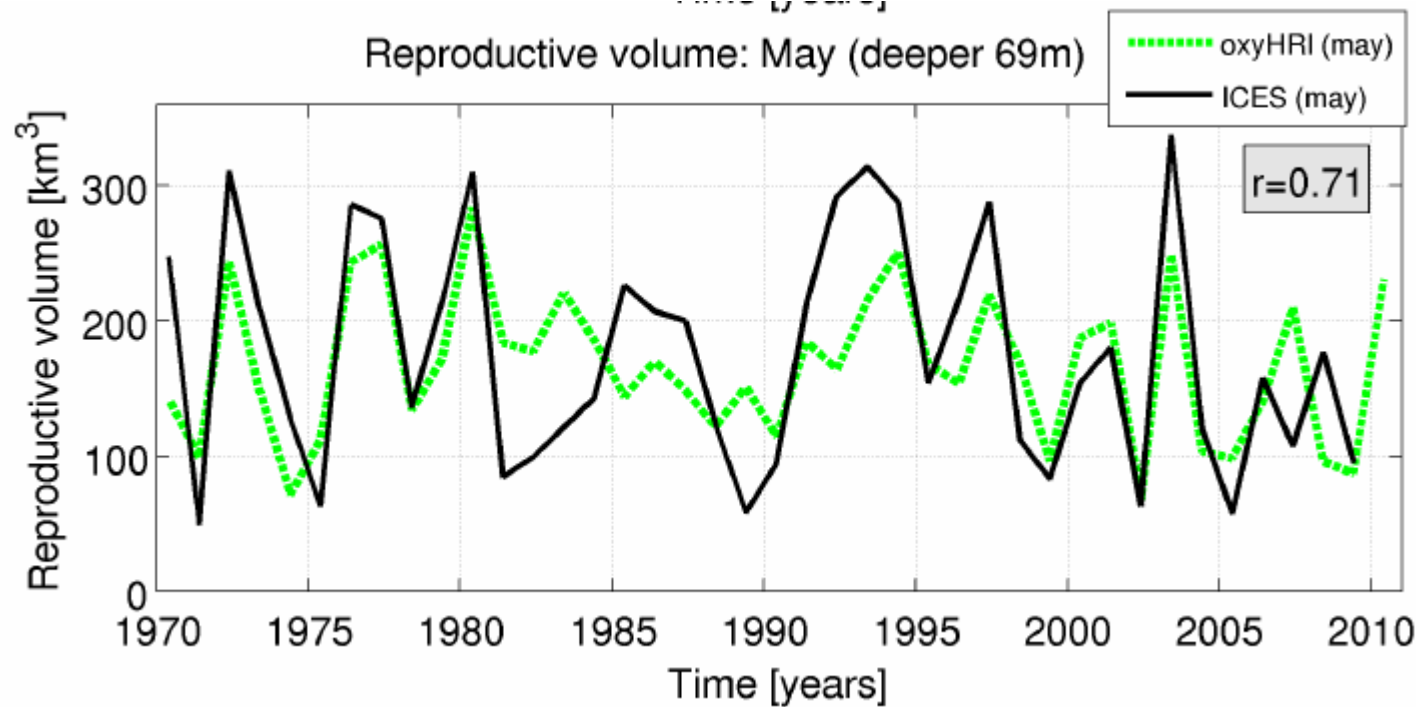
Results

Extent of hypoxic & anoxic bottom water



Results

Baltic cod reproductive volumes



Time series of the Baltic cod reproduction volumes in the Bornholm basin based on Observations (ICES) and hindcast model results (BSIOM), location with water depths > 69 m

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Conclusions

- Model results are in reasonable well agreement with observations
- The coupled hydrodynamic - oxygen consumption model is suitable to describe the development of oxygenated, hypoxic and anoxic areas in the Baltic Sea
- The model is a suitable tool for detailed analysis of ecological and environmental interactions (e.g. habitat estimation studies, reproduction volumes)
- Limitations are due to constant basin-wide oxygen consumptions rates associated with the annual mean primary production
- This offers a possibility for sensitive studies (temperature, eutrophication etc.)
- Improvements could be achieved if better spatially and temporally resolved primary production rates for the different sub-basins would be available