Projected impact of climate change in the North and Baltic Sea. Results from dynamical downscaling of global CMIP climate scenarios

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The Problem:

Climate models predict most substantial changes for mid/high latitudes but they do not adequately resolve shelves

Regional models have to prescribe mass and energy fluxes at their domain boundaries

Therefore...

Models

- **Ocean GCM** including dynamic thermodynamic sea ice (Hibbler, 1979)
- 1.5° (10 km), 0.6° (4 km), free surface
- 30 vertical z levels
- no SST restoring
  no SSS restoring in the Baltic
- **Regional Atmosphere REMO**
  37 km 27 vertical levels
- **Biogeochemistry model**
  (modified NPZD model
  including sediment model)

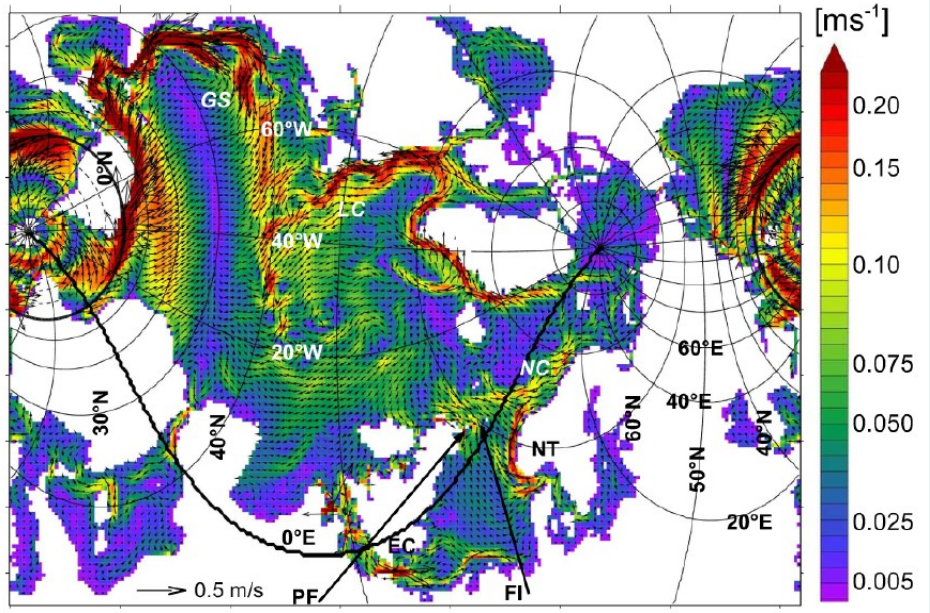


Fig. 1. Model domain. Also shown: surface circulation averaged over 1990–1999. Only fou
second vector is shown. EC = English Channel, NT = Norwegian Trench, PF = Pentland Fi
FI = Faire Island, NC Norwegian Current, LC = Labrador Current, GS = Gulf Stream.

Model validation of is available at:
Gröger et al. (2012): NW European shelf under climate warming: Implications for open ocean – shelf exchange, primary production, and carbon absorption.

http://www.biogeosciences-discuss.net/9/16625/2012/bgd-9-16625-2012.html

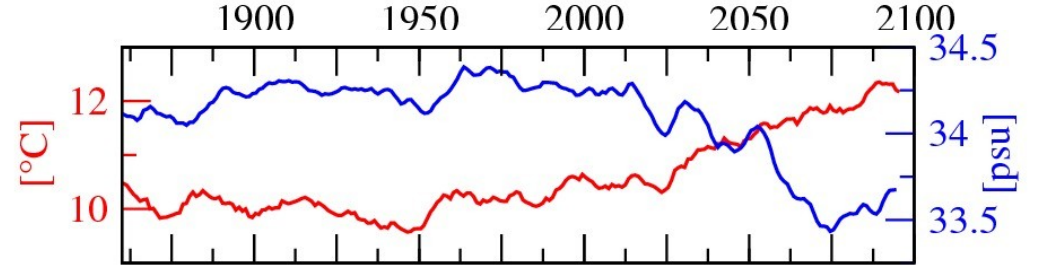
Scientific Questions

1. How does climate change affect hydrography and biology in the North Sea?

2. Climate impact on the Baltic Sea

IPCC SRES A1B downscaled to NW European shelf

North Sea hydrography
(yearly mean average over the entire North Sea area)



Surface temperature
Surface salinity

IPCC SRES A1B downscaled to NW European shelf

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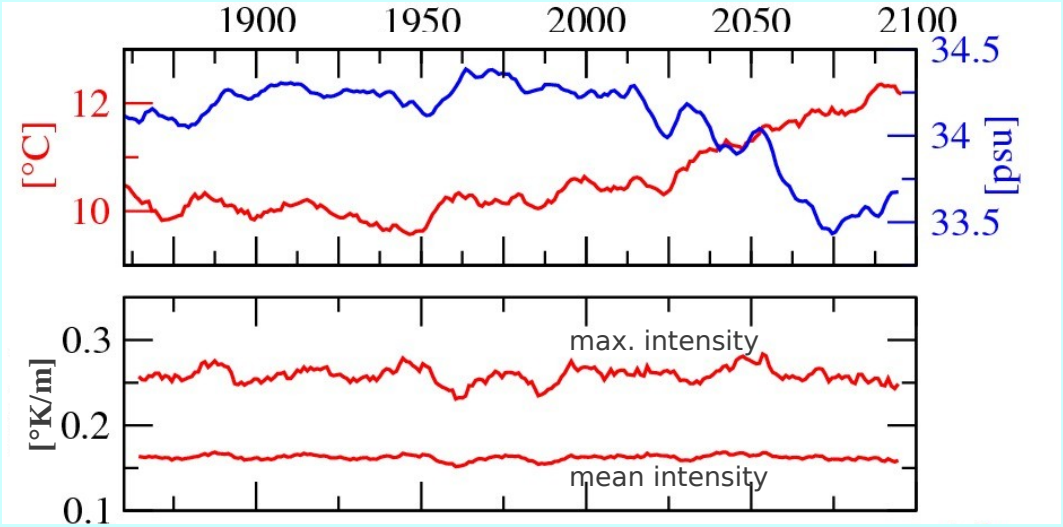

Surface temperature

Surface salinity

Thermocline intensity

(max. temperature gradient in the water column)

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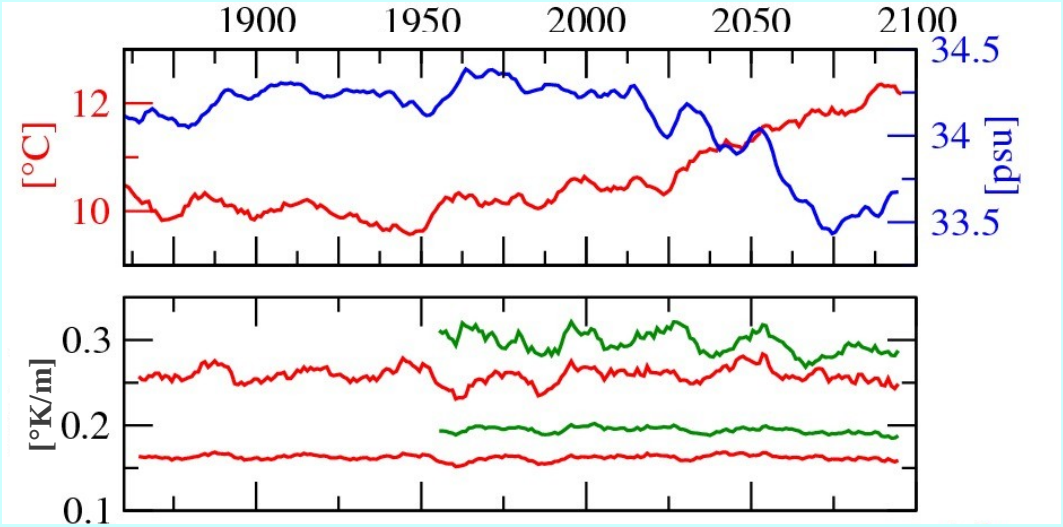

Surface temperature

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Thermocline intensity

(max. temperature gradient in the water column)

(ECHAM5)/REMO/HAMSOM

(*pers. communication Moritz Mathis, IFM Hamburg*)

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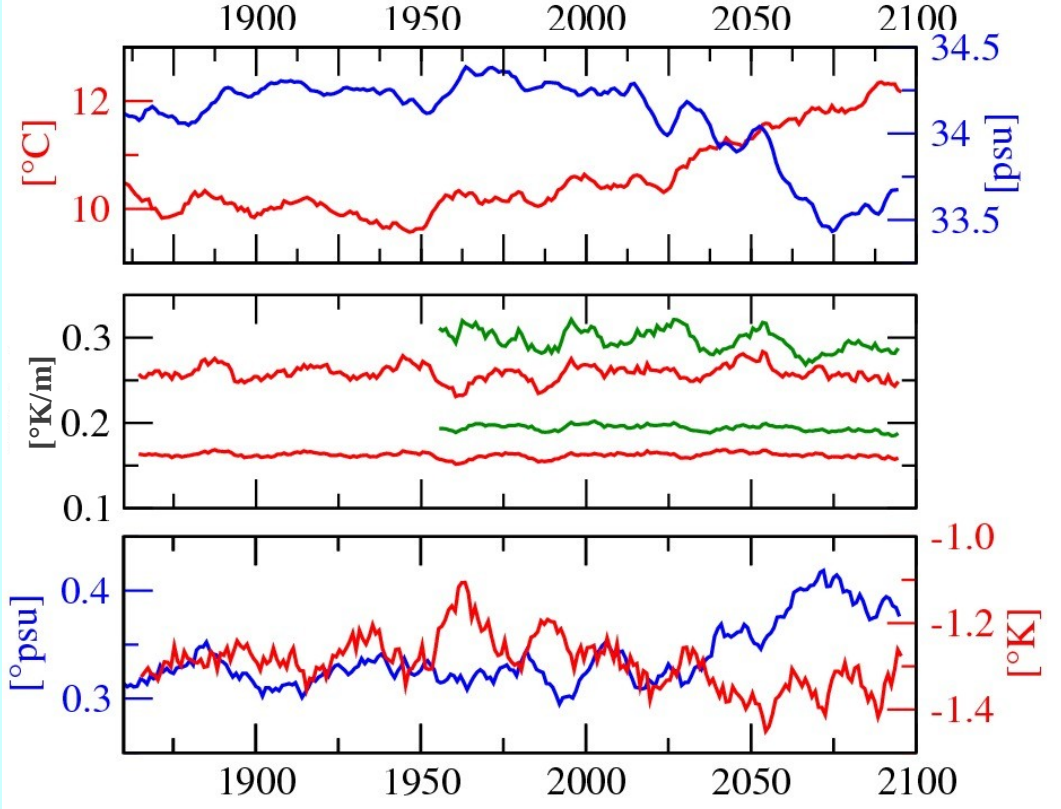
(yearly mean average over the entire North Sea area)



Surface temperature
Surface salinity

Thermocline intensity
(max. temperature gradient in the water column)

REMO/HAMSOM
(*pers. communication Moritz Mathis, IFM Hamburg*)

Bottom minus surface salinity and temperature

=> <u>stronger stratification...?</u>

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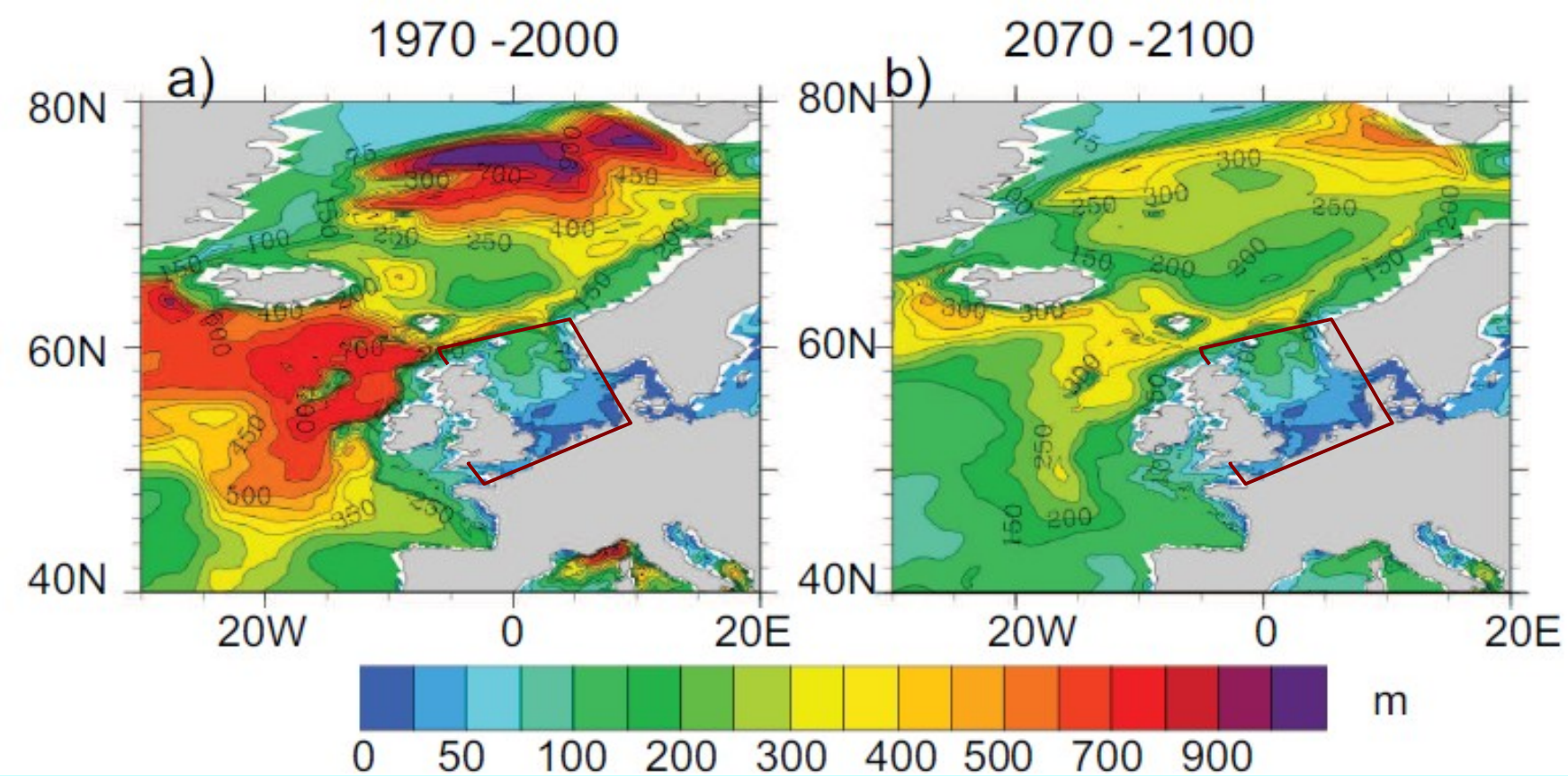
Slope hydrography Winter mixed layer depth



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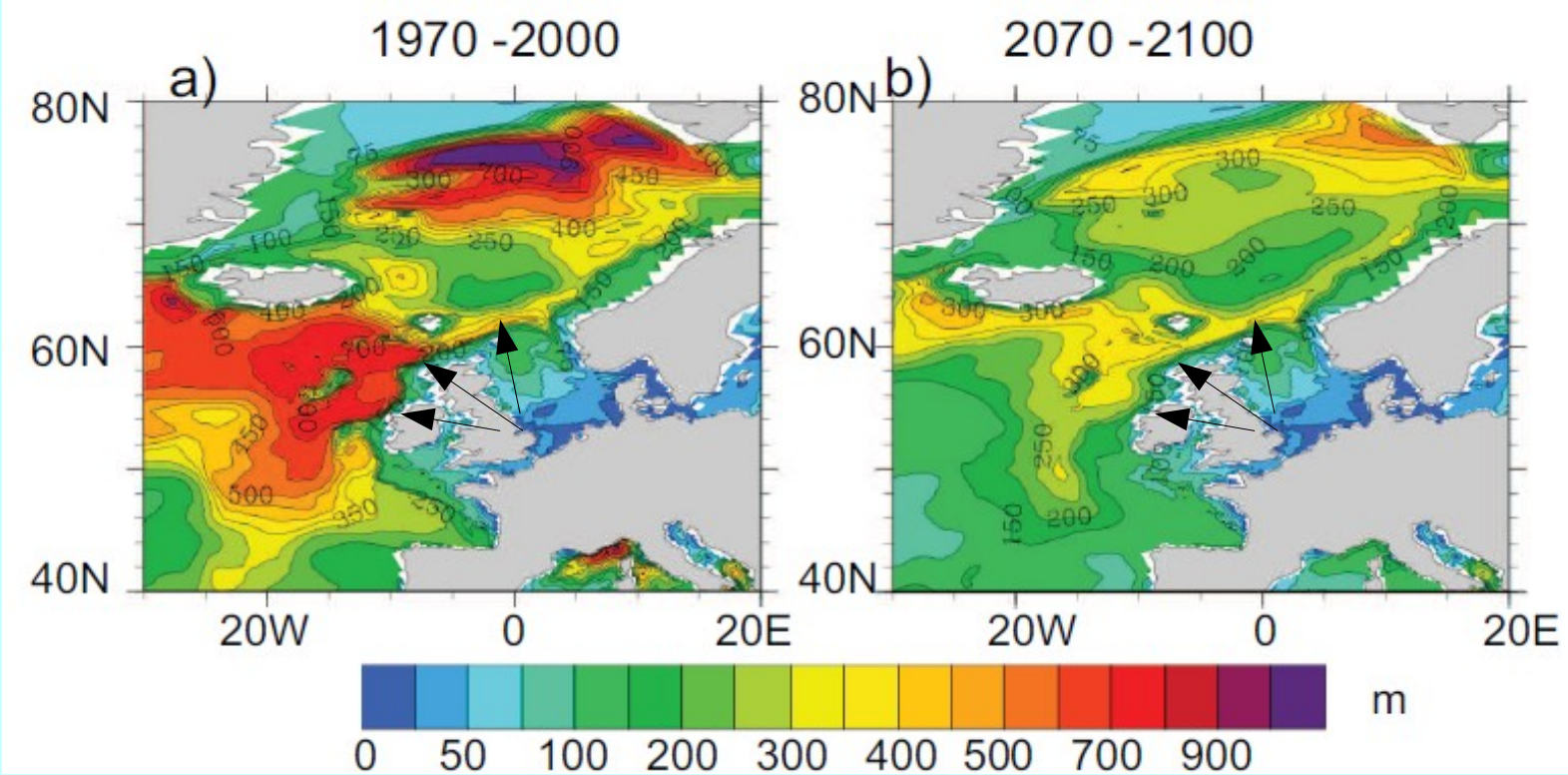
Slope hydrography

Winter mixed layer depth



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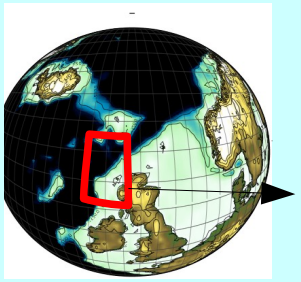
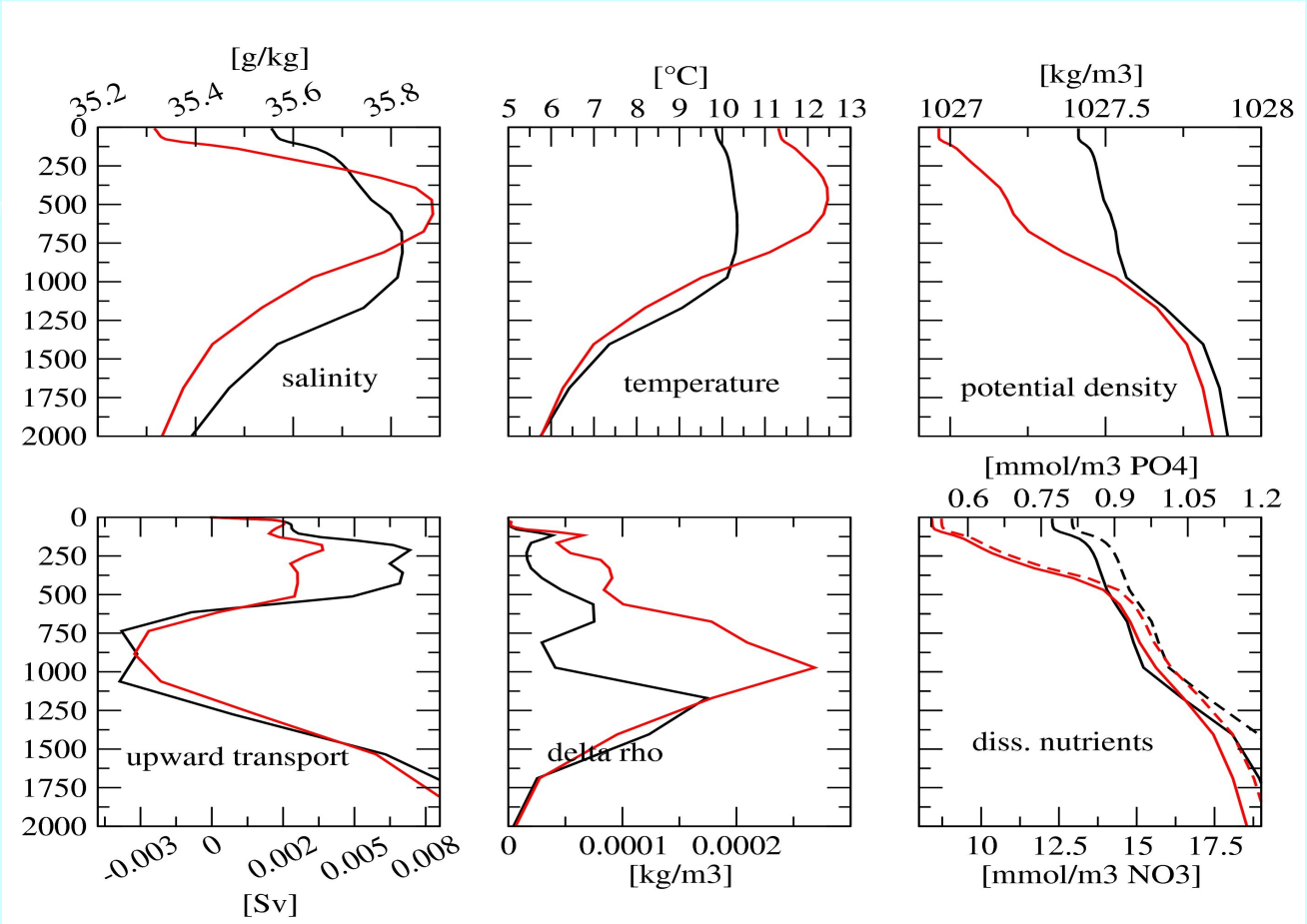
Slope hydrography



black: average 1980-1999
red: average 2080-2099



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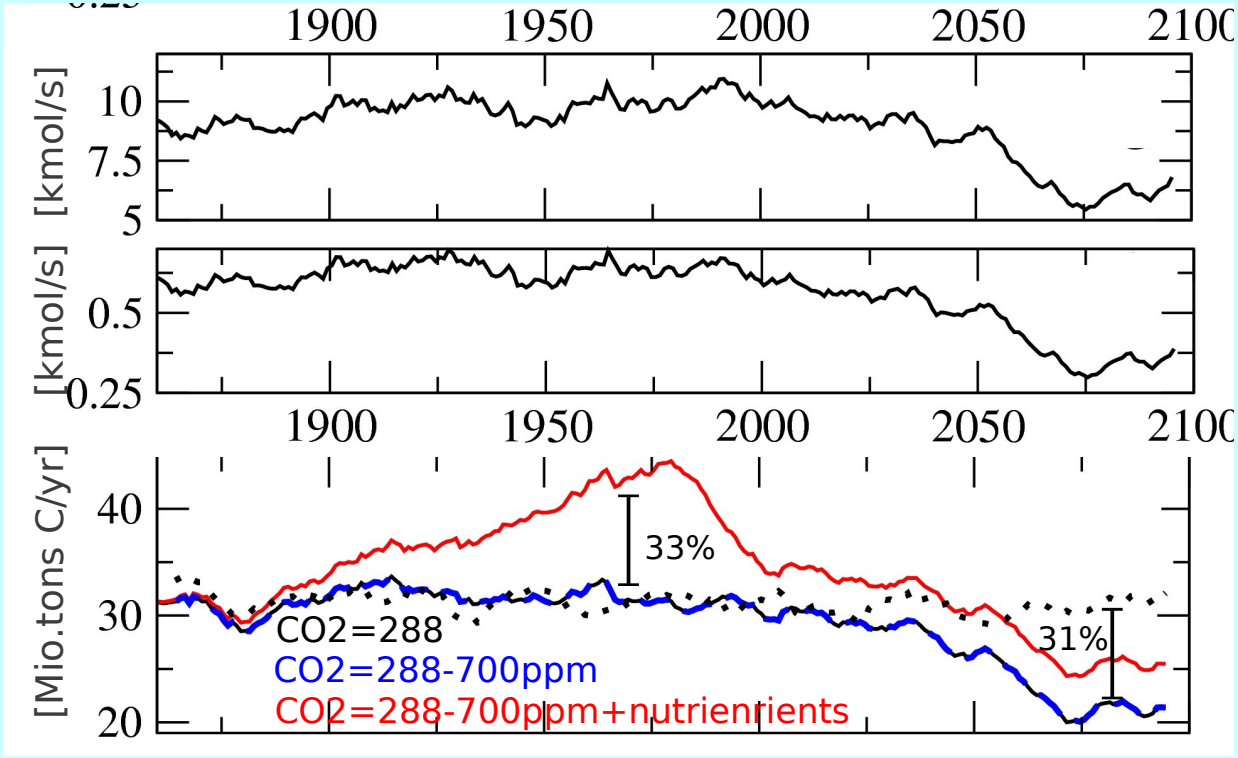
Integrated biogeochemical Parameters of the North Sea

thanks to J.Paetsch for providing riverine nutrient loads



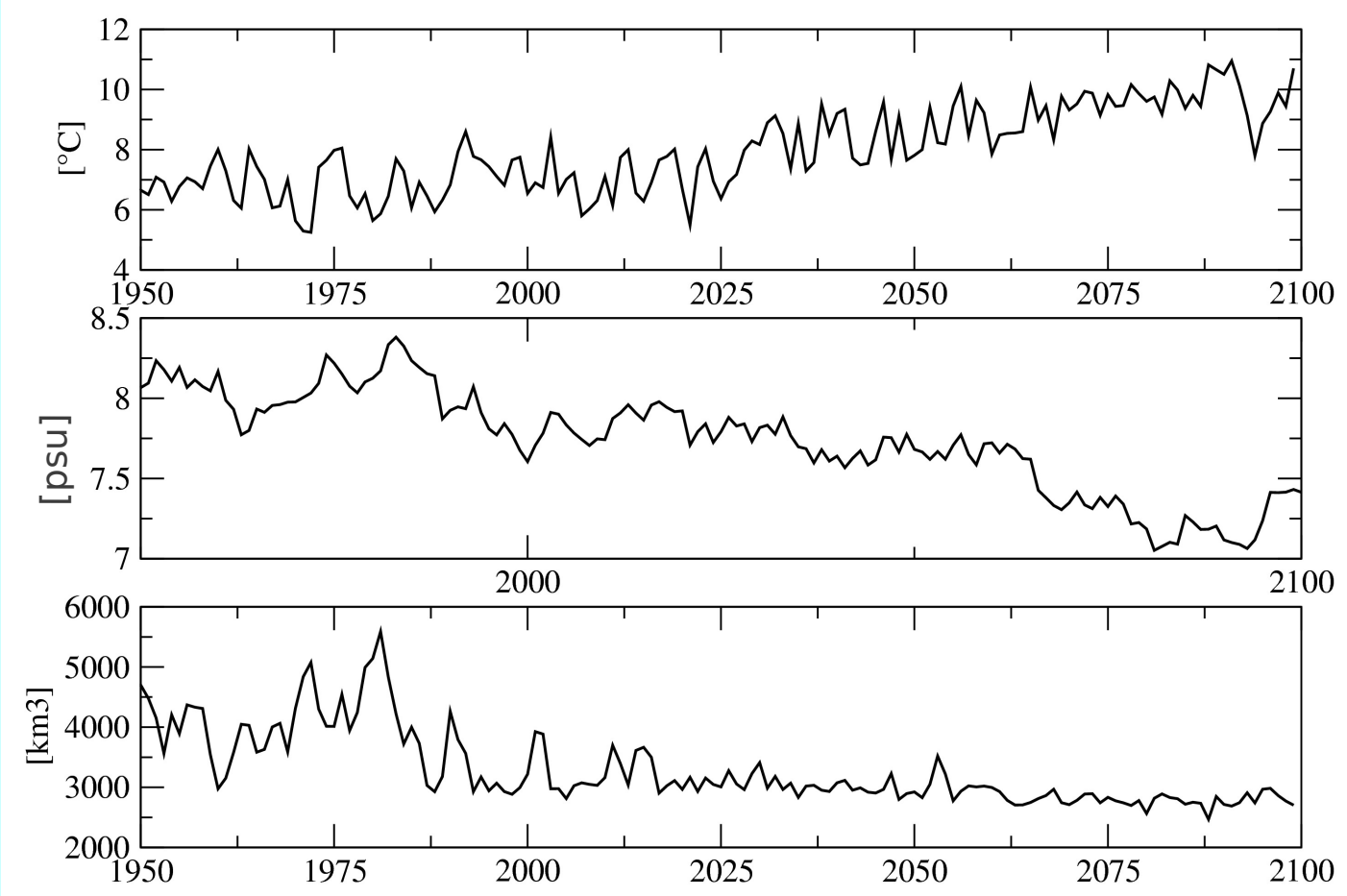
Transport of nitrate into the North Sea across the shelve break

Transport of phosphate into the North Sea across the shelve break

Yearly integrated primary production

IPCC SRES A1B downscaled to NW European shelf

Hydrographic changes in the Baltic Sea
(yearly mean averaged over the Baltic Sea area)



Average SST

Average SSS

water volume
>11 psu

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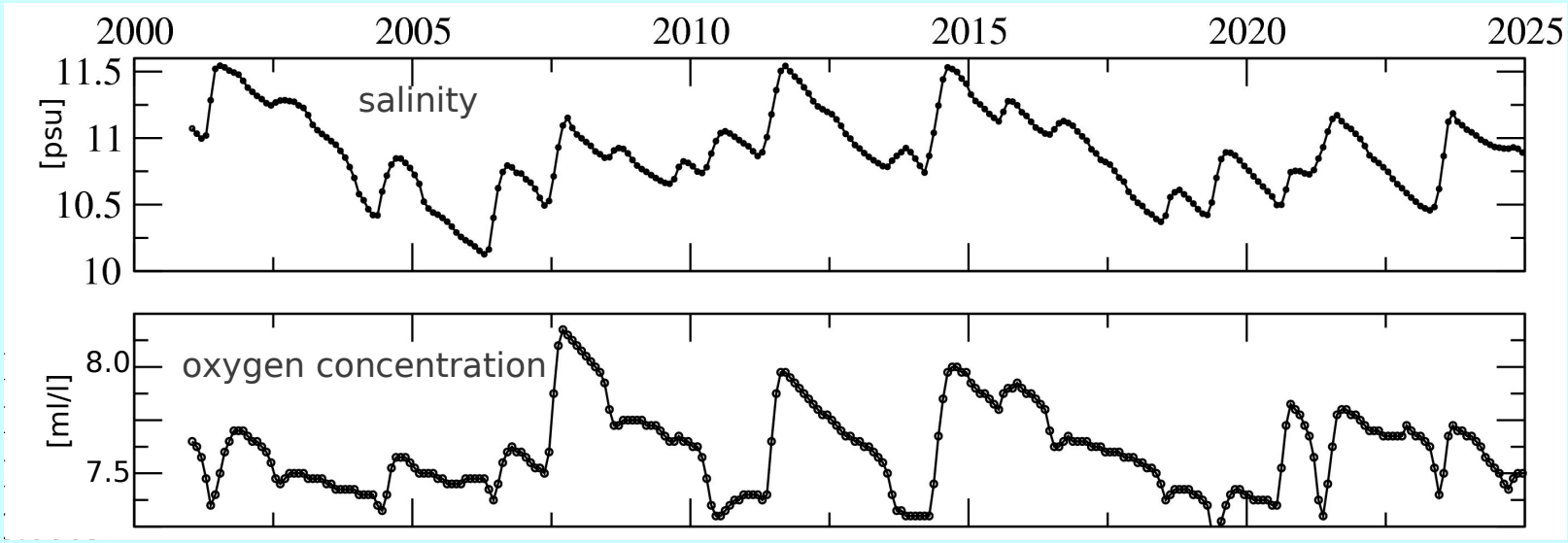
Monthly mean

Hydrography of the Gotland Basin **19°E; 56°N; 140m depth**



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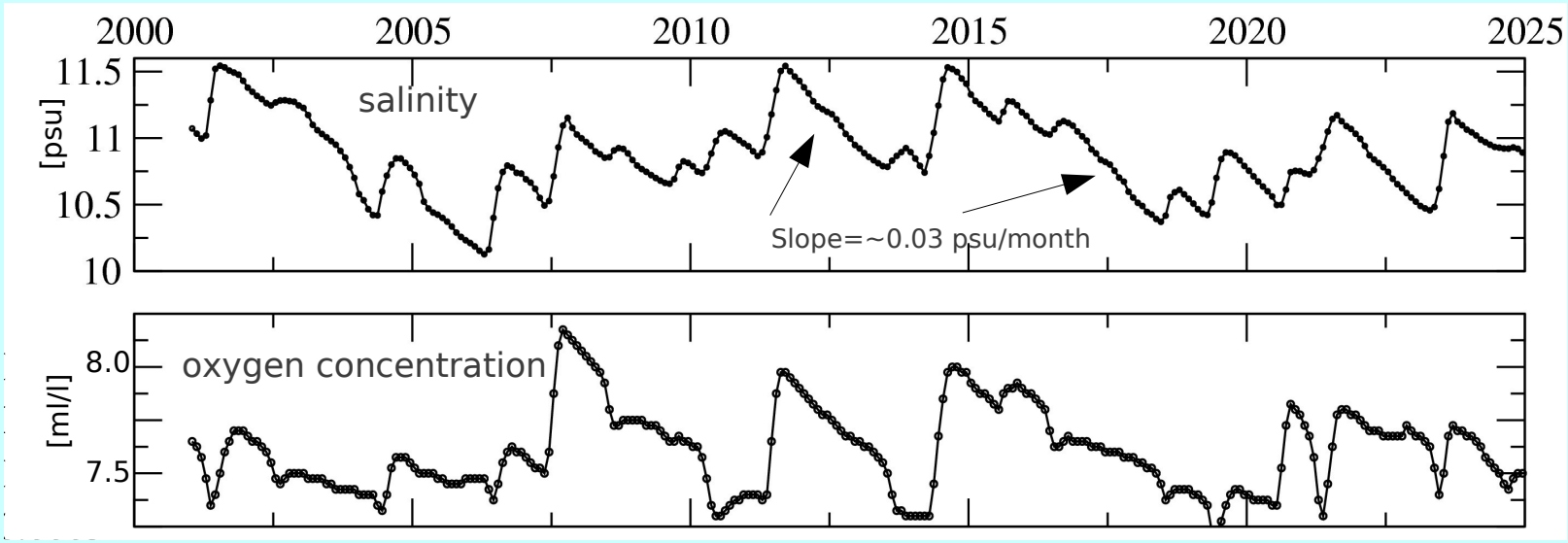

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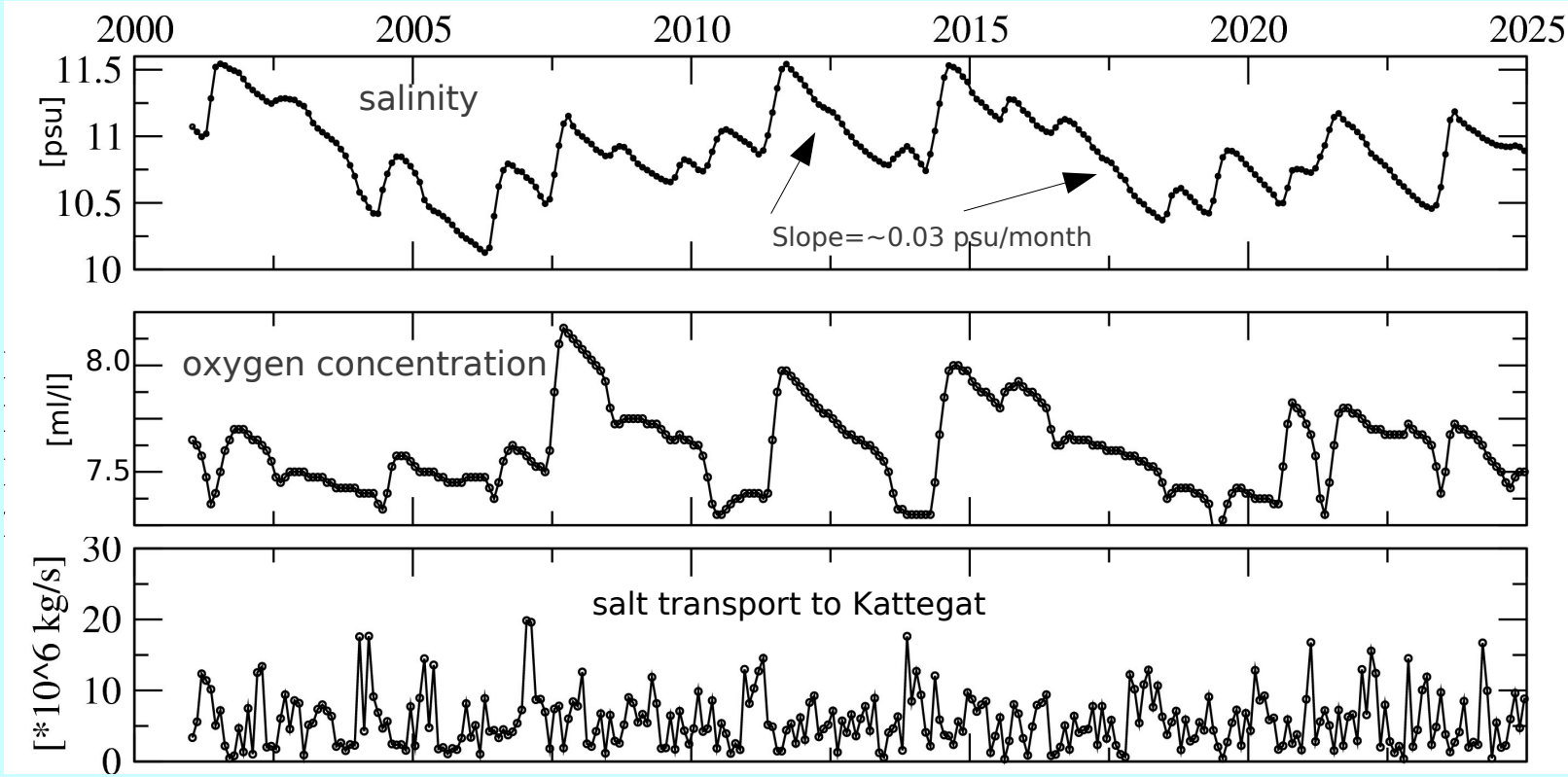

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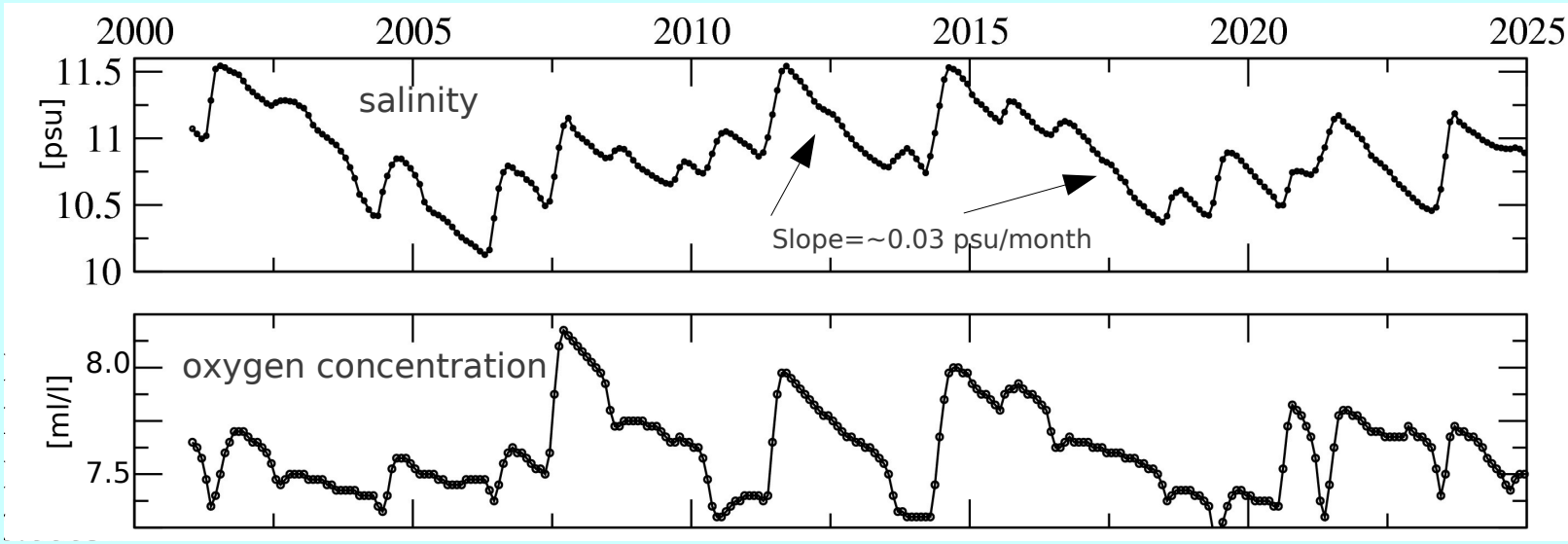

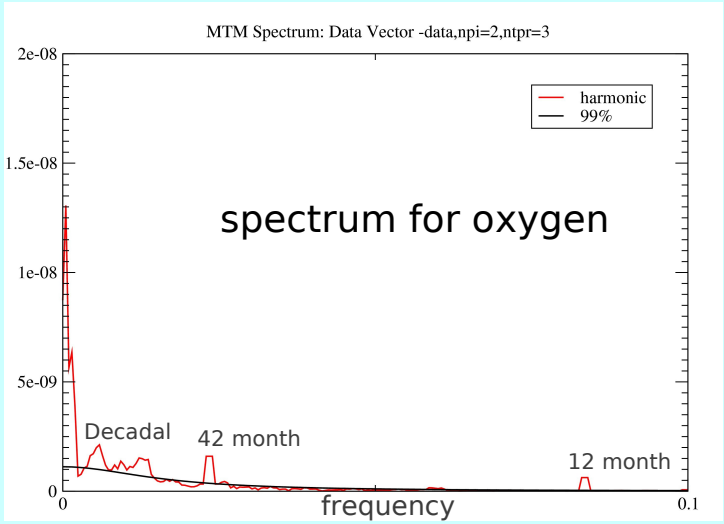

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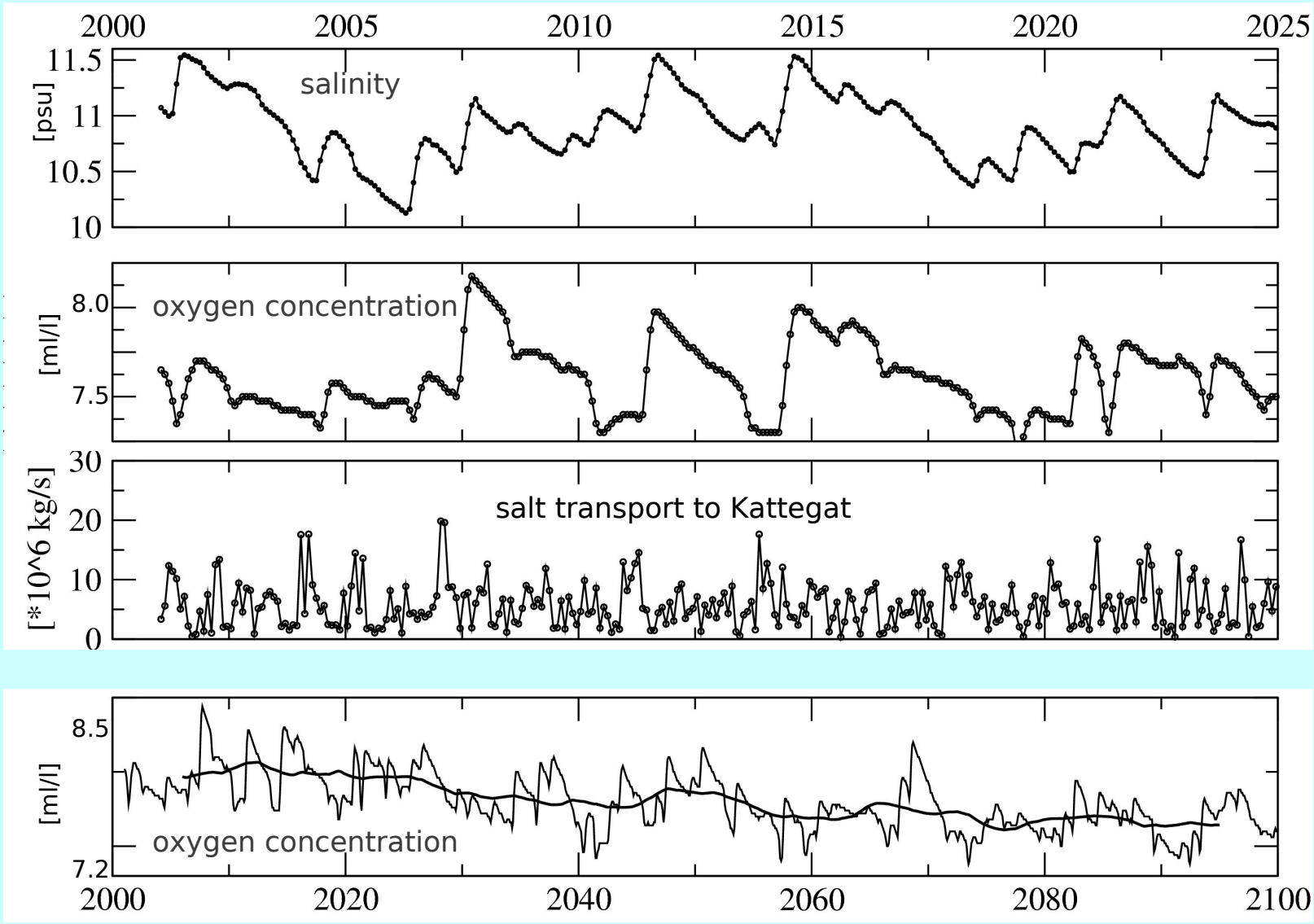

Summary

North Sea Hydrography

- **surface temperature increases by ~2 K**
- **surface salinity drops by 0.7 psu**
- **stratification increase considerably due to runoff and import from the Baltic – no smooth response!**

After 2050

- **nutrient supply from the adjacent Atlantic declines and lowers productivity**
- **stabilization of the water column along the shelf break.**
- **North Sea is decoupled from deep Atlantic.**