An integrated modelling environment for MaBenE based on GOTM and GETM

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Structure of model environment

The model environment consists of

- GOTM-based turbulence module
- GOTM-based biogeochemical module
- GOTM-based air-sea interaction module
- GOTM-based mussel module
- One-dimensional model environment GOTM
- Three-dimensional model environment GETM:
  - is using GOTM modules
  - includes high-order advection schemes
  - allows for drying and flooding of intertidal flats
  - is based on general vertical coordinates
  - runs on parallel computers

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NEW!

Dec. 15, 2005:
Release of GOTM 3.2.2

Dec. 08, 2005:
New plotting release

Mixing in lakes:
Do you know FLake?

Online: 5
Today: 24
Yesterday: 101
Total: 16535

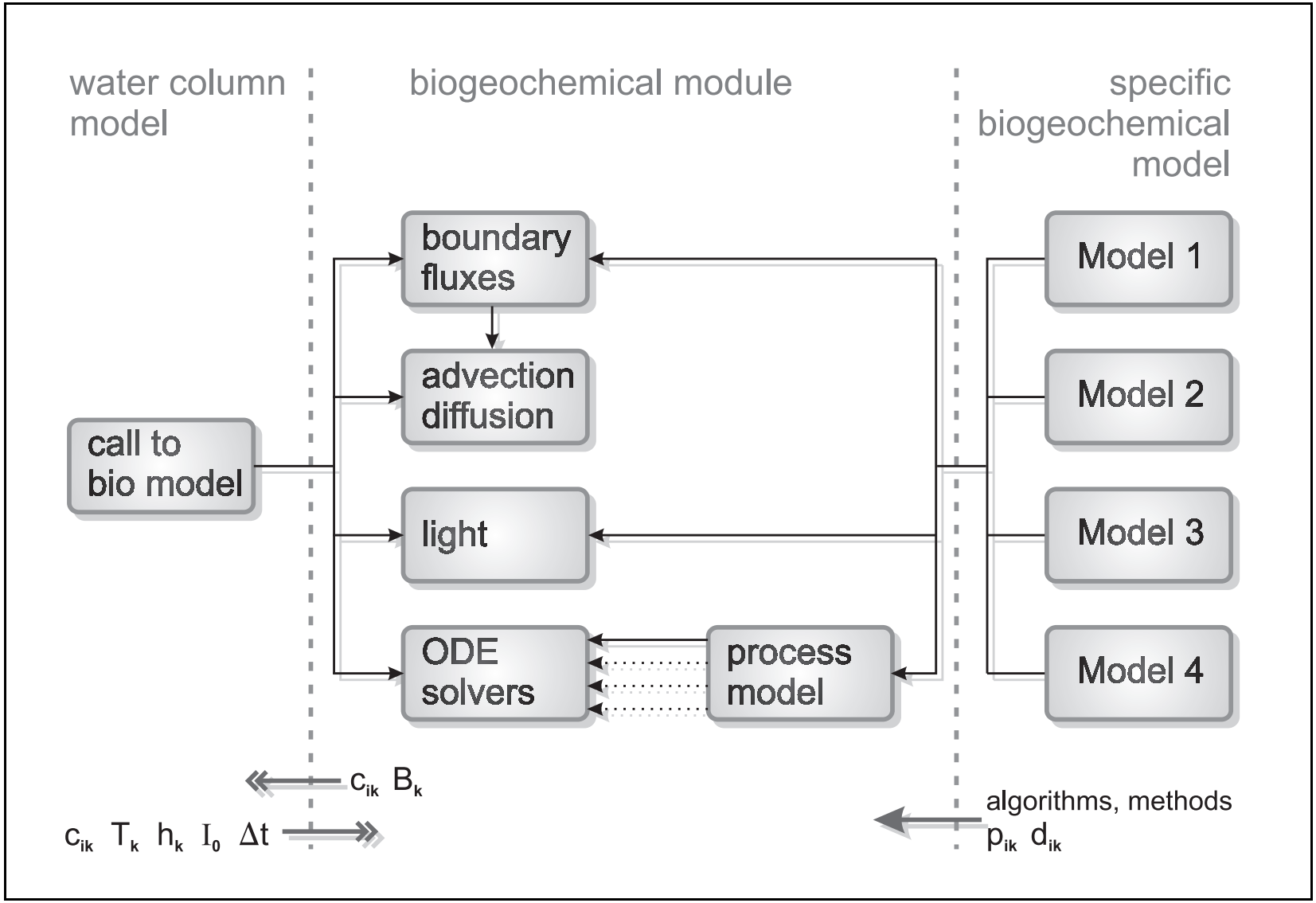
About GOTM

General Ocean Turbulence Model (GOTM) is an ambitious name for a one-dimensional water column model for marine and limnological applications. It is coupled to a choice of traditional as well as state-of-the-art parameterisations for vertical turbulent mixing. The package consists of the FORTRAN90 software, a number of idealised and realistic test cases, and a scientific documentation, all published under the GNU public license. GOTM is, of course, not complete (and will never be). Whoever is missing any feature in GOTM, is warmly invited to contribute to GOTM and add her or his personal preferences or needs.

The idea behind GOTM is to provide a simple and well-documented tool that can be used to

- learn about the physics and numerical treatment of vertical mixing processes in natural waters by using a suite of prepared test cases,
- compare the performances of various turbulence schemes in different oceanic regimes (or compare them to known analytical solutions),
- integrate your own oceanic data into GOTM, and simulate numerically the water column processes under investigation.

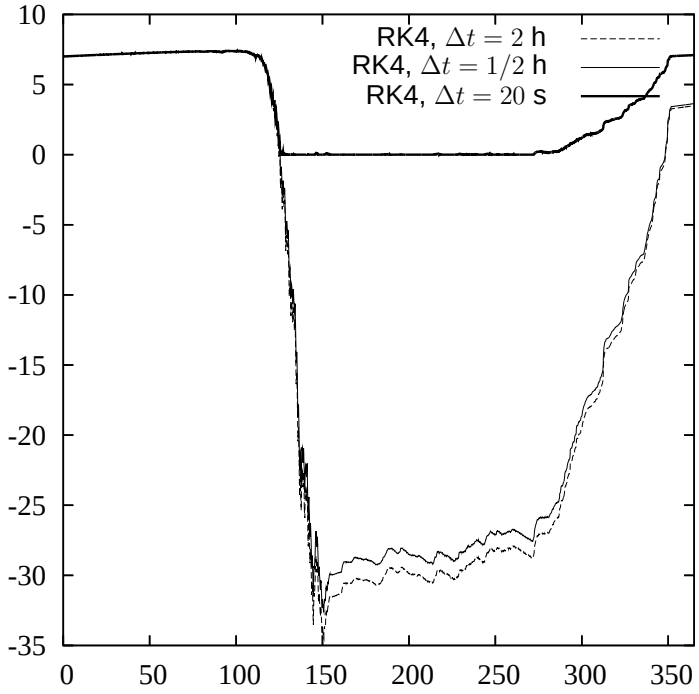
Coupling GOTM with modules



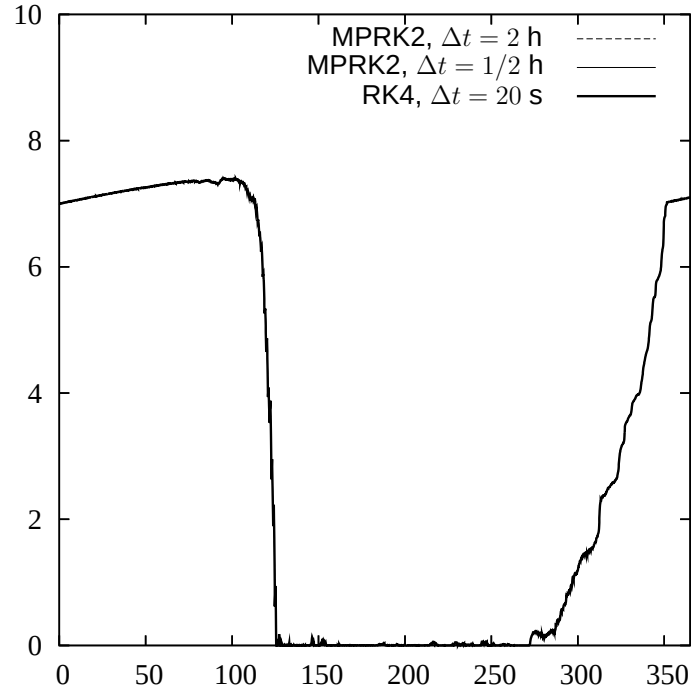
Numerical schemes for GOTM-BIO

Various schemes for biogeochemical processes have been developed for GOTM-BIO, such as the Modified Patankar schemes by Burchard, Meister and Deleersnijder (2003, 2005) and the Extended Modified Patankar schemes by Bruggeman, Burchard, Sommejer and Kooi (2006).

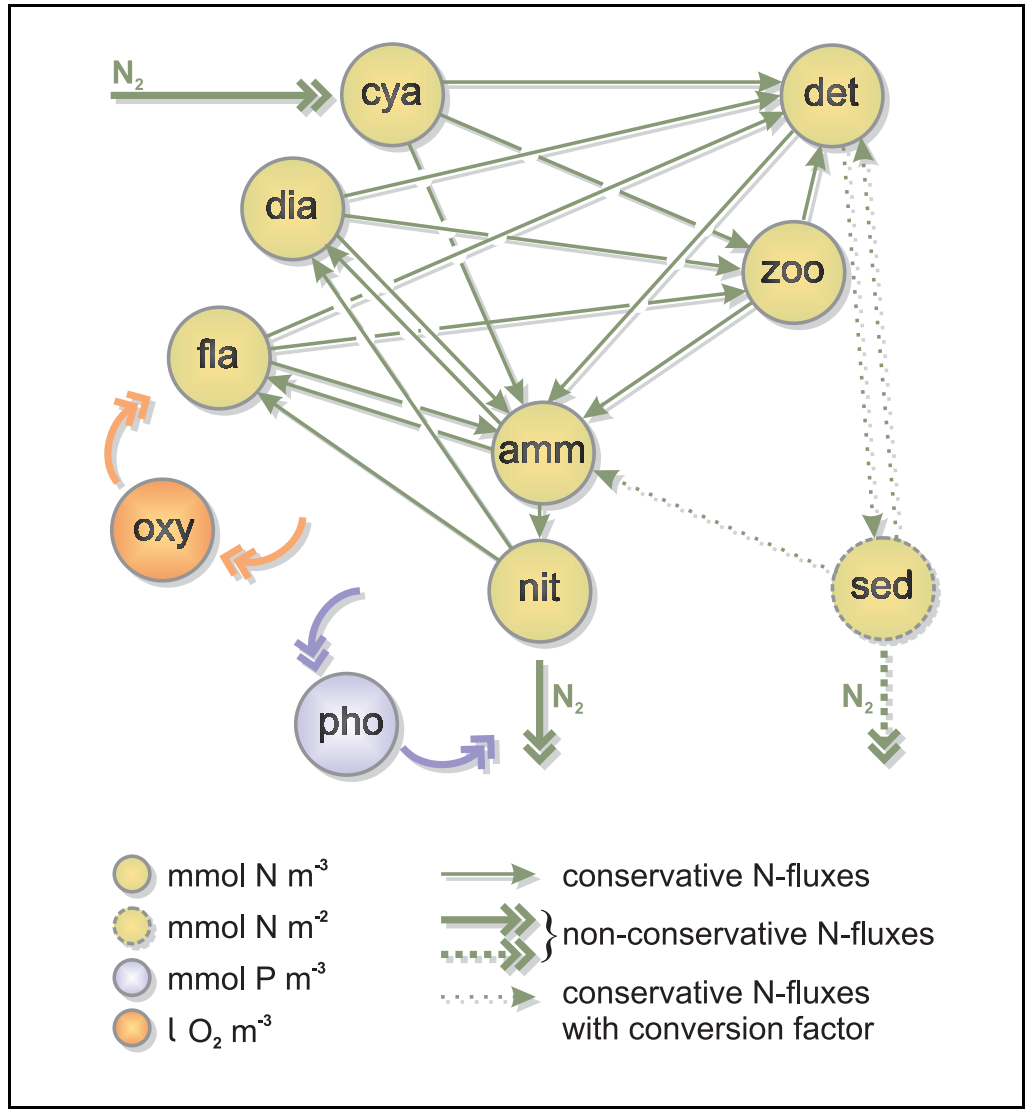
4th-order Runge-Kutta



Modified Patankar-Runge-Kutta



MaBenE biogeochemical model



Silt equation added to this model, original model from Burchard et al. [2006], based on neumann et al. [2002].

GOTM setup for Limfjord

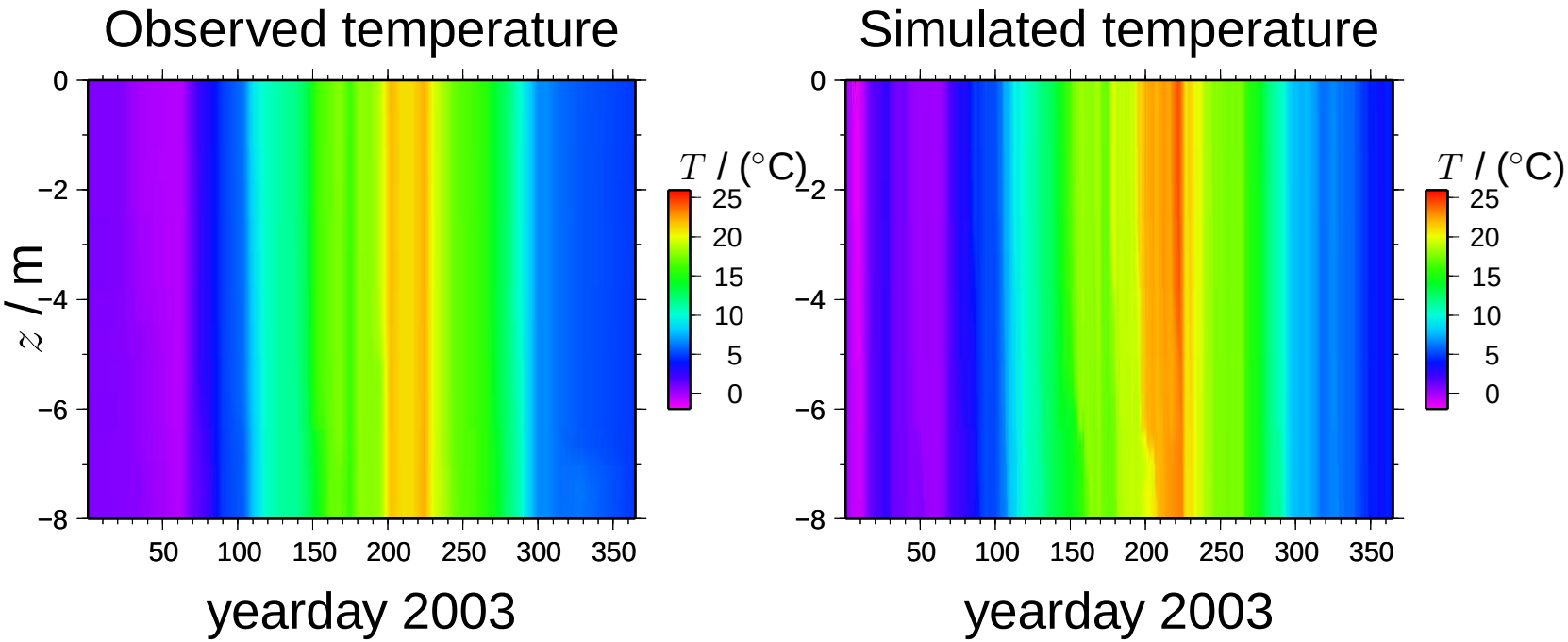
The Limfjord 1D simulations serve the purpose to find reasonable initial conditions and empirical parameters for 3D simulations.

- Position located at Løgstør Breding monitoring station with a depth of 8 m.
- The whole year 2003 is simulated.
- Surface forcing is provided from MaBenE meteorological observations on Livø.
- Salinity is relaxed to observations.
- Mean horizontal density gradient estimated from 3D model calculations.
- Surface slopes determined from 3D model.

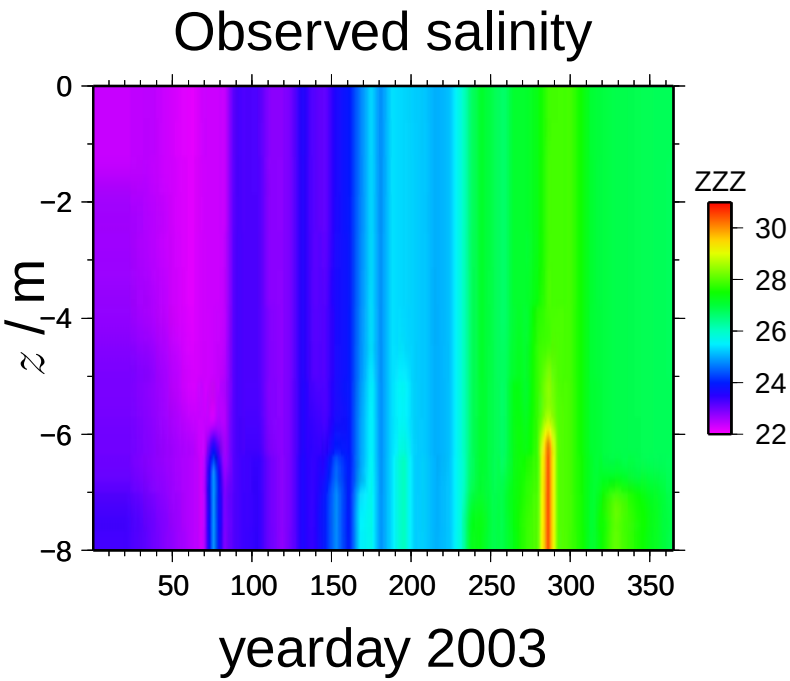
GOTM setup for Limfjord, cont.

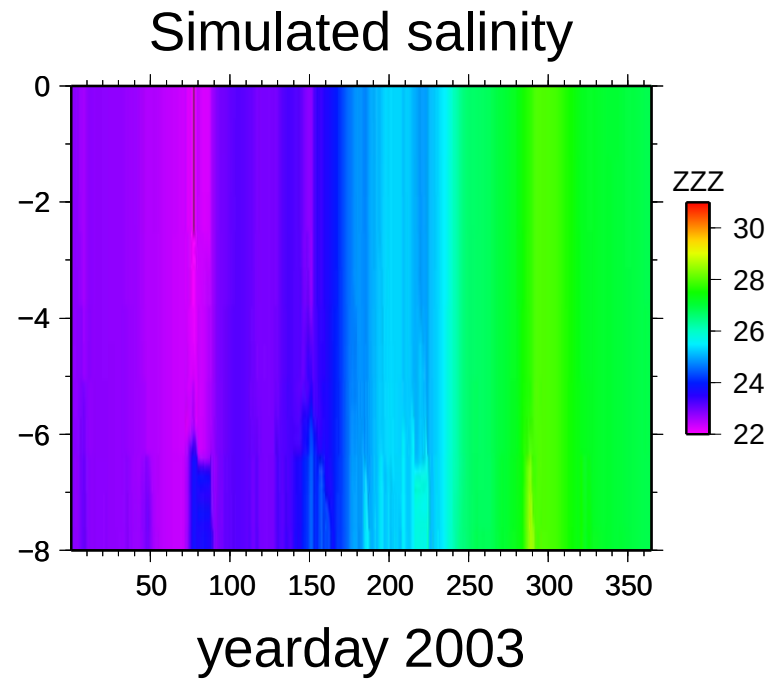
- The MaBenE biogeochemical model is applied here, which is the Neumann et al. (2002) and Burchard et al. (2006) model, modified by a silt equation and new oxygen saturation formulation (Weiss 1970).
- Initial conditions for total nitrogen contents of water column is estimated from observations (by Torkel G. Nielsen, for diffeent year).
- No nutrient boundary fluxes are assumed.
- No mussel filtration is assumed.
- Results for oxygen may be compared with observations.

Limfjord simulation, temperature

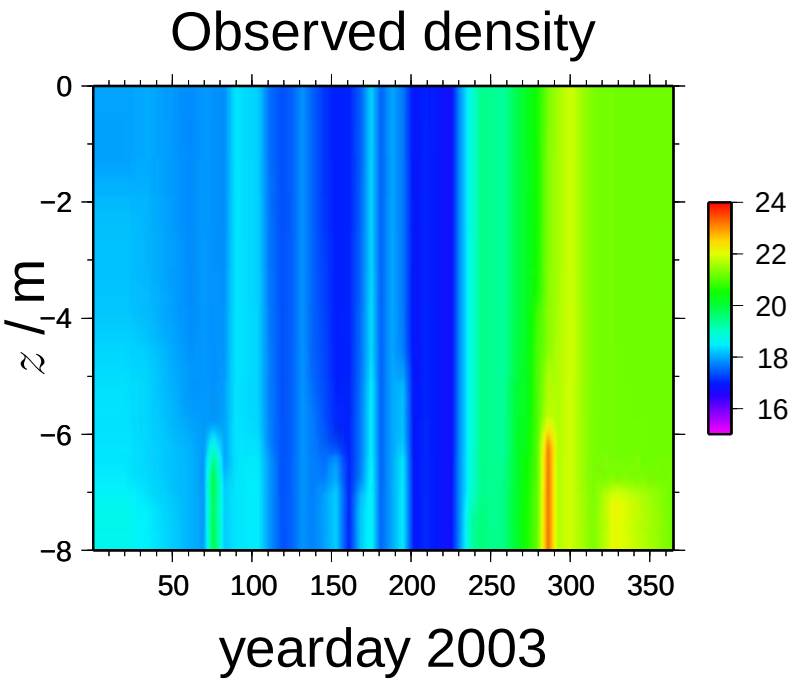


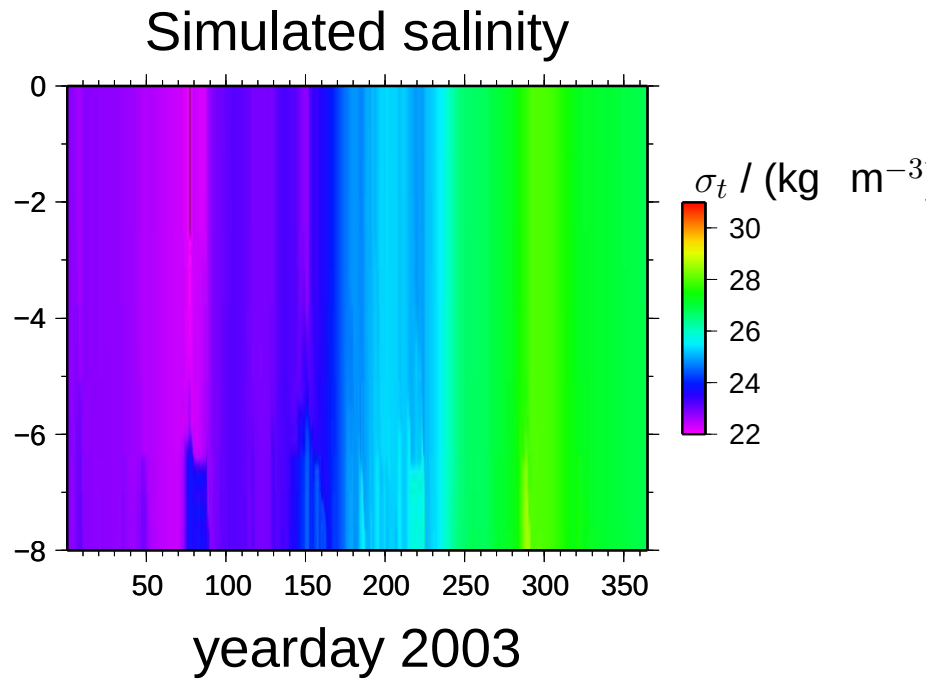
Limfjord simulation, salinity



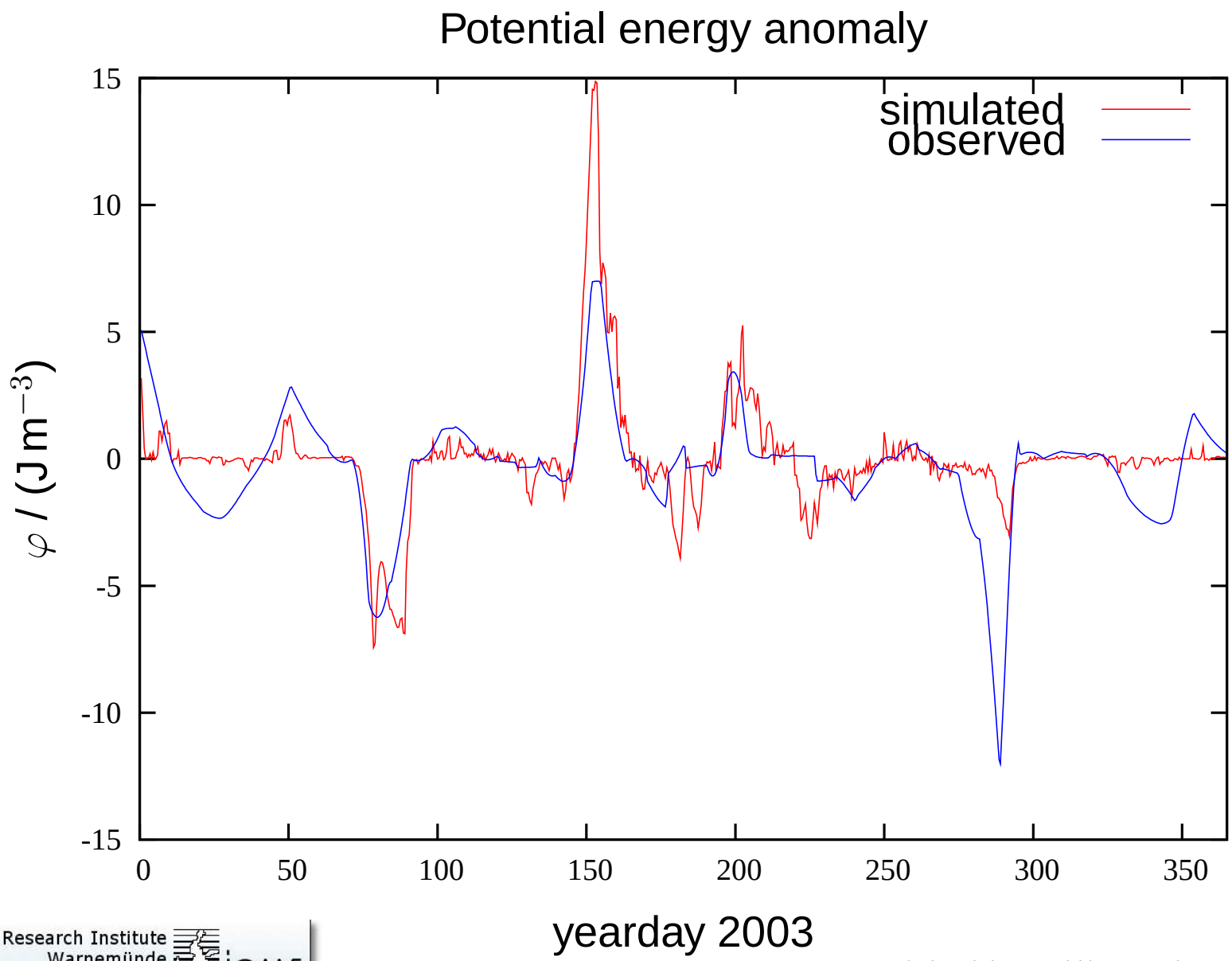


Limfjord simulation, density

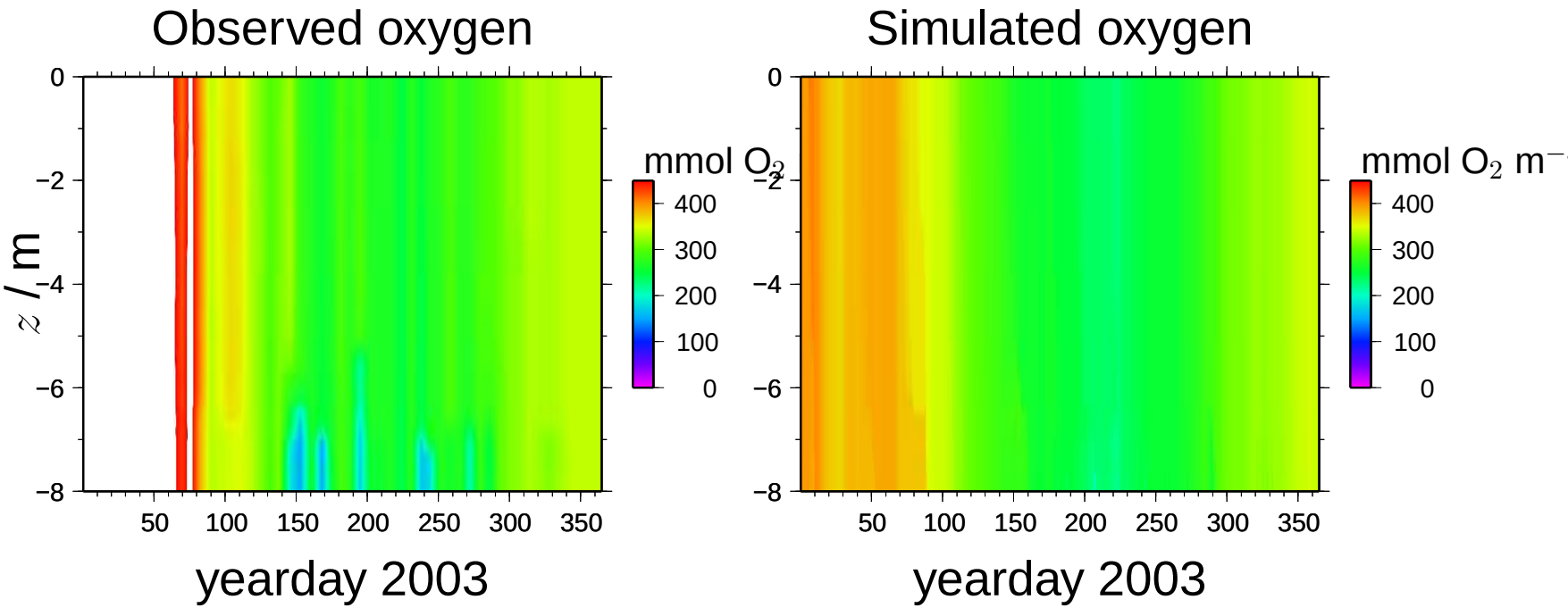




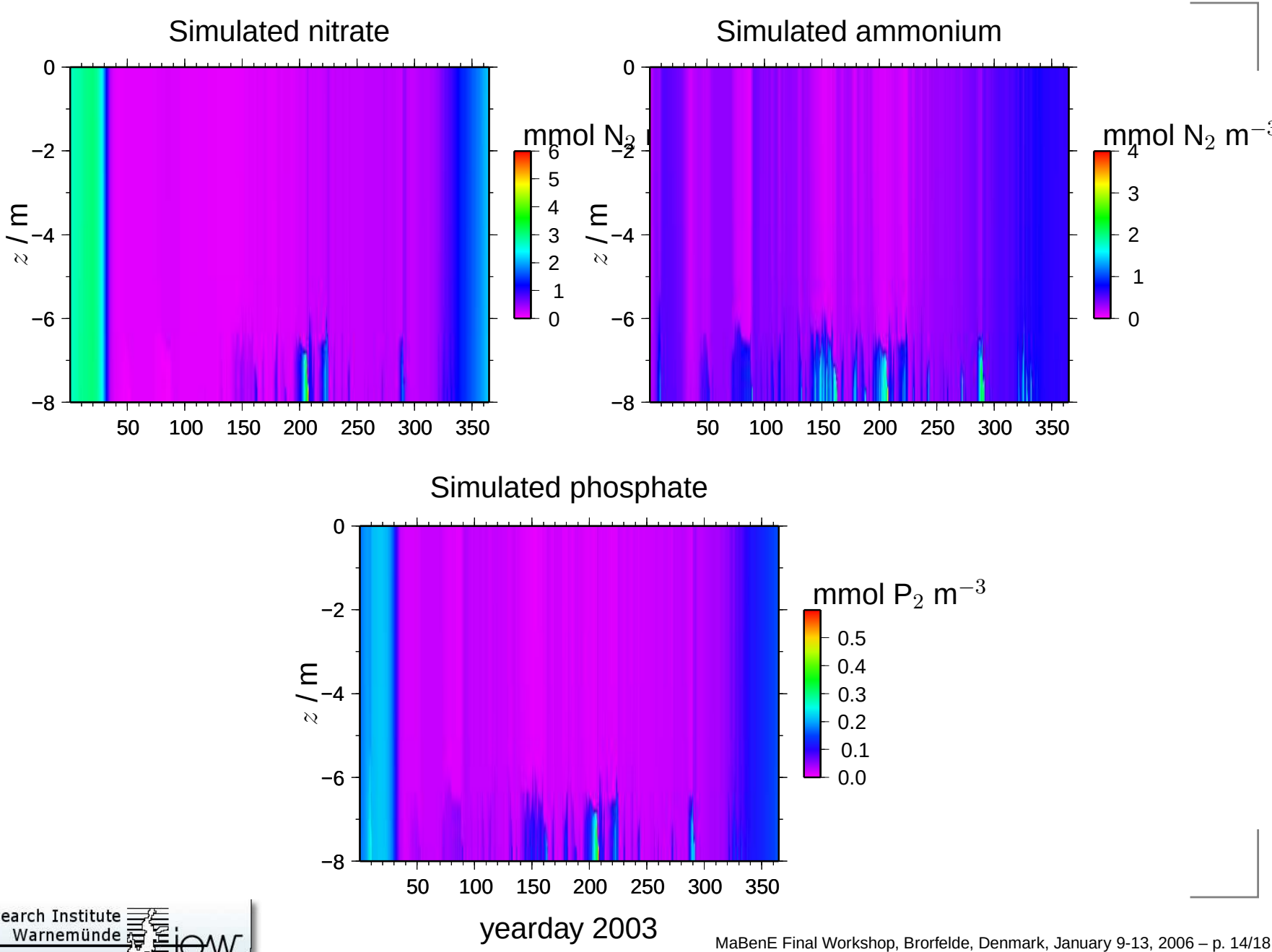
Potential density anomaly



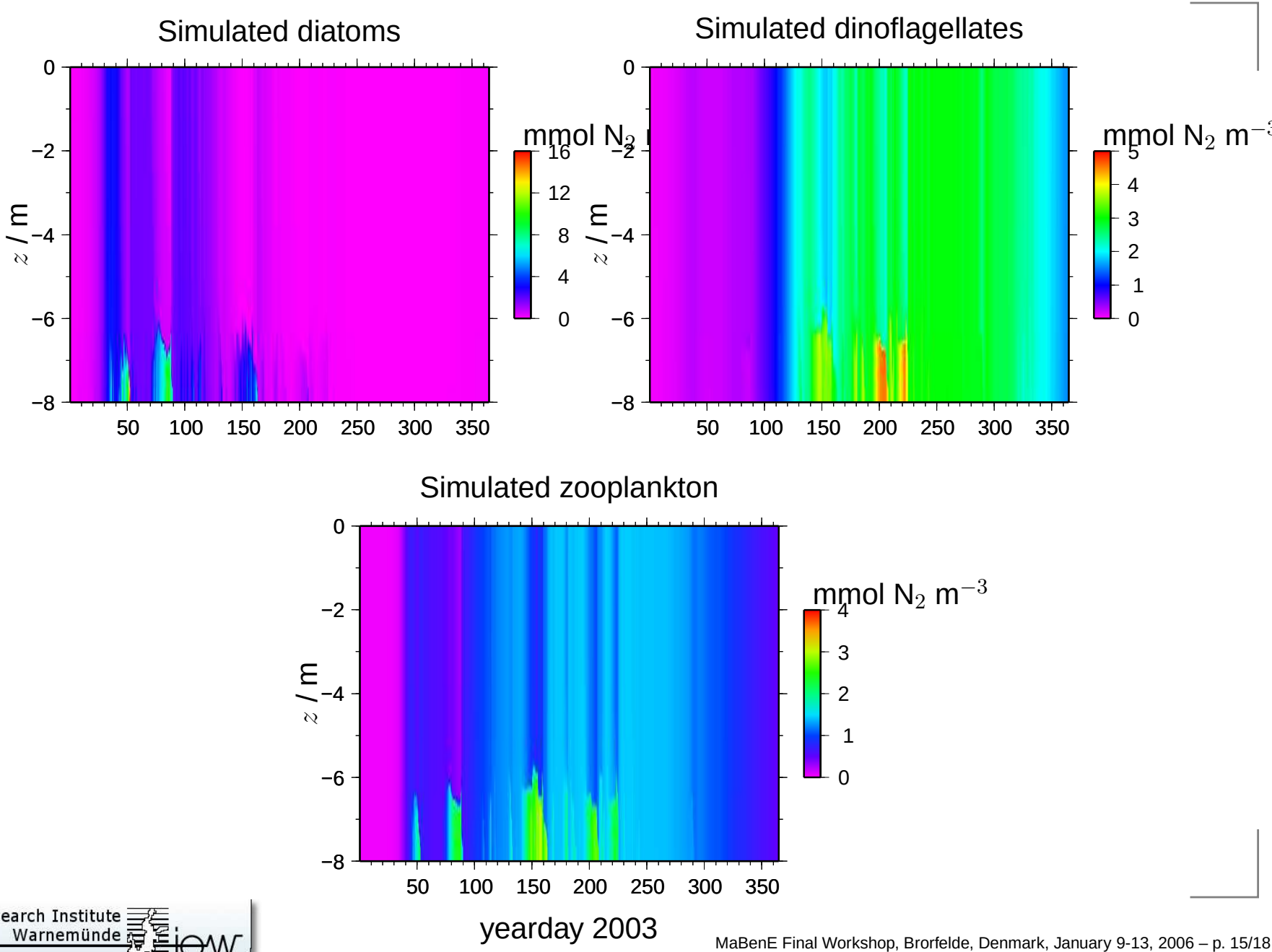
Limfjord simulation, oxygen



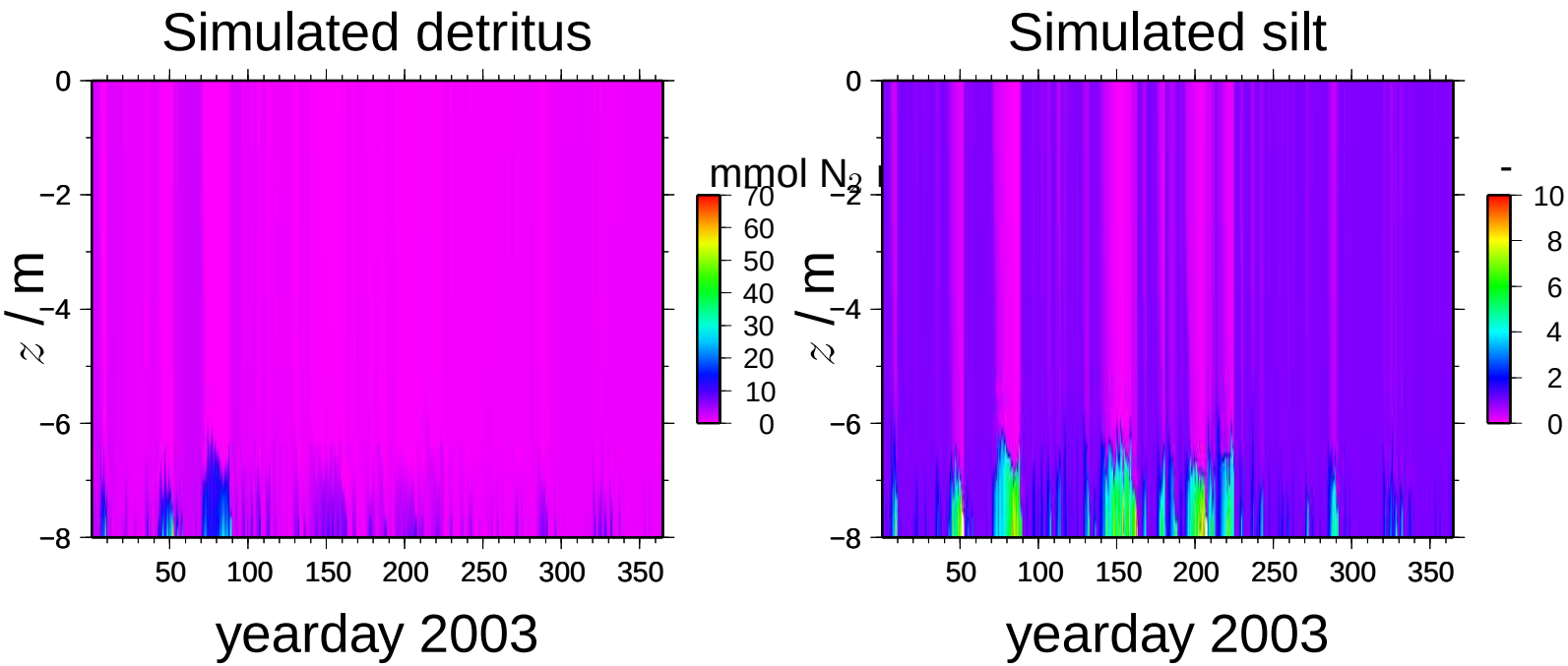
Nutrients


Simulated nitrate
Simulated ammonium
Simulated phosphate
z / m
mmol N2 m−3
mmol P2 m−3
yearday 2003

Phytoplankton & zooplankton



Limfjord simulation, suspended matter



MaBenE mussel module

A dynamic energy budget model has been developed for MaBenE as joint effort of BBH, DMU, NIOO, and IST. The major features are:

- Budget equations for core weight, storage weight and gametes.
- Core weight needs maintenance, on the account of storage weight.
- Small mussels put energy into core and storage, larger mussels put energy into gametes production.
- Gametes production depends on storage weight, spawning occurs at suffiently high temperature and high gametes weight.

MaBenE mussel module, cont.

- Clearance rate depends on temperature, core weight, phytoplankton, detritus and silt concentration.
- Selection of phytoplankton over detritus and silt, rejection as pseudofaeces.
- Assimilation efficiency of ingested food depends on silt content and gut passage time.
- Full coupling to pelagic model, by ingestion of phytoplankton, detritus and silt, and egestion of detritus (faeces, pseudofaeces), excretion of phosphate and ammonium and consumption of oxygen.