One-dimensional physical modelling in Løgstør Bredning

Hans Burchard[1,2], and Karsten Bolding[3]

hans.burchard@io-warnemuende.de

1. Bolding & Burchard Hydrodynamics, Rostock, Germany

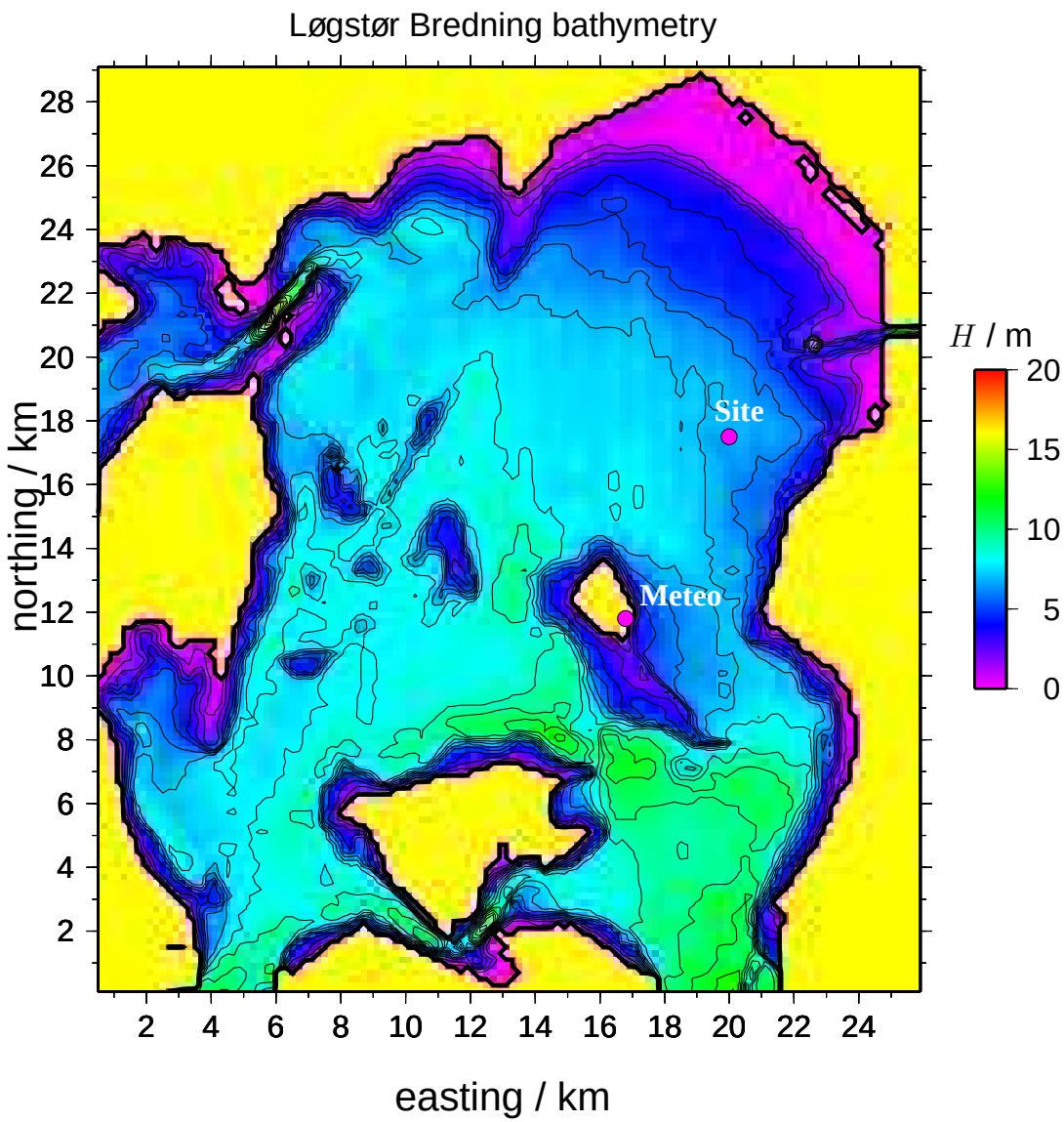
2. Baltic Sea Research Institute Warnemünde, Germany

3. Bolding & Burchard Hydrodynamics, Asperup, Denmark

Program

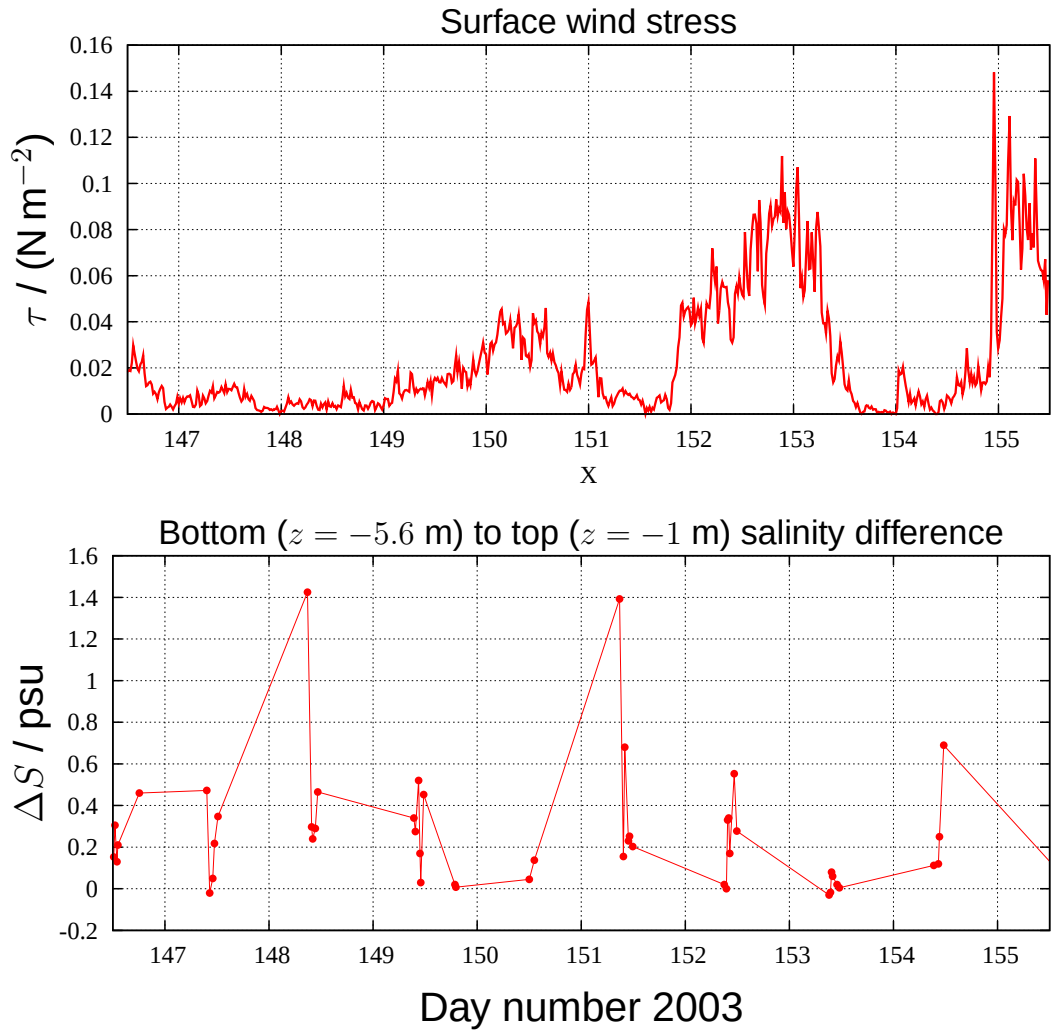
- Some analysis of the observations in Løgstør Bredning
- Set-up of the one-dimensional GOTM simulation
- Some comparison between model results and observations
- Some more model results
- Discussion

Løgstør Bredning bathymetry



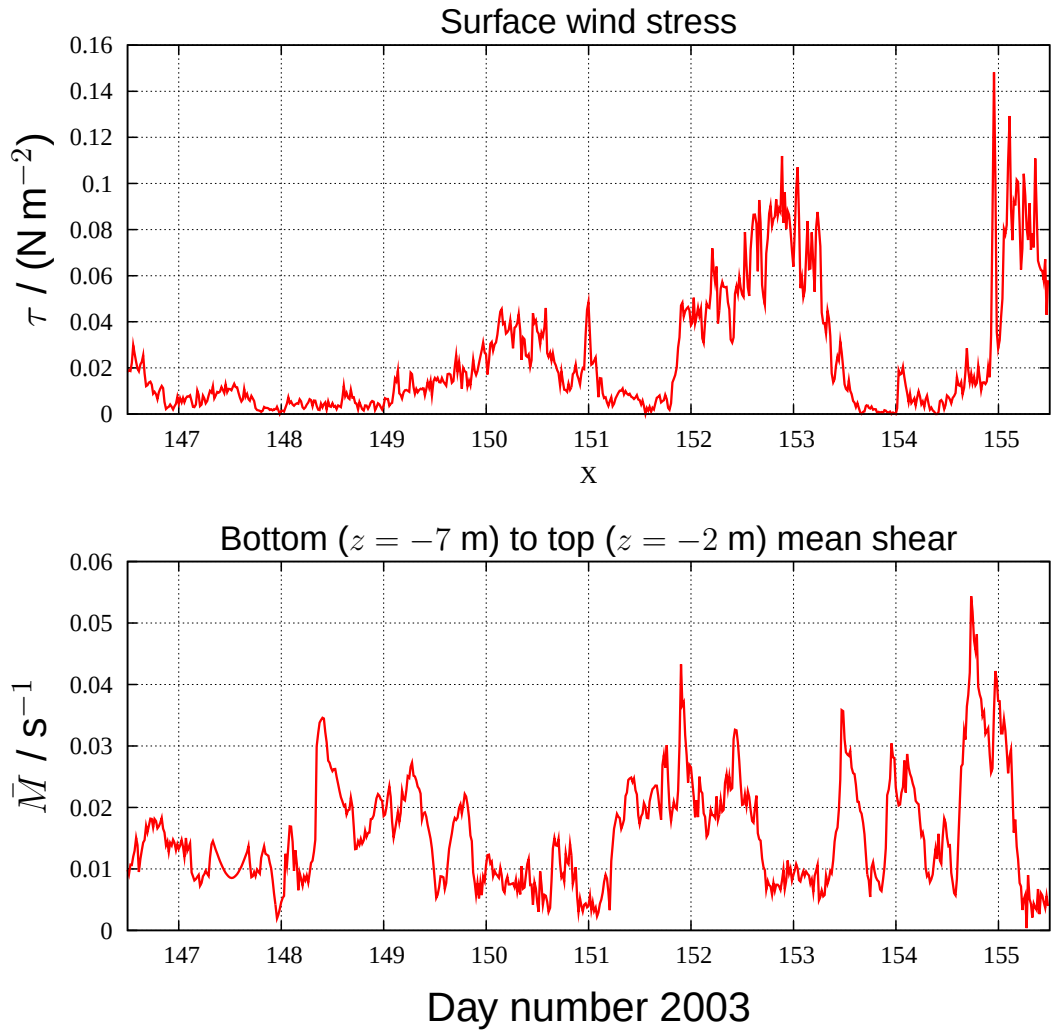
Red dots show campaign site and location of meteorological station.

Wind stress vs. stratification



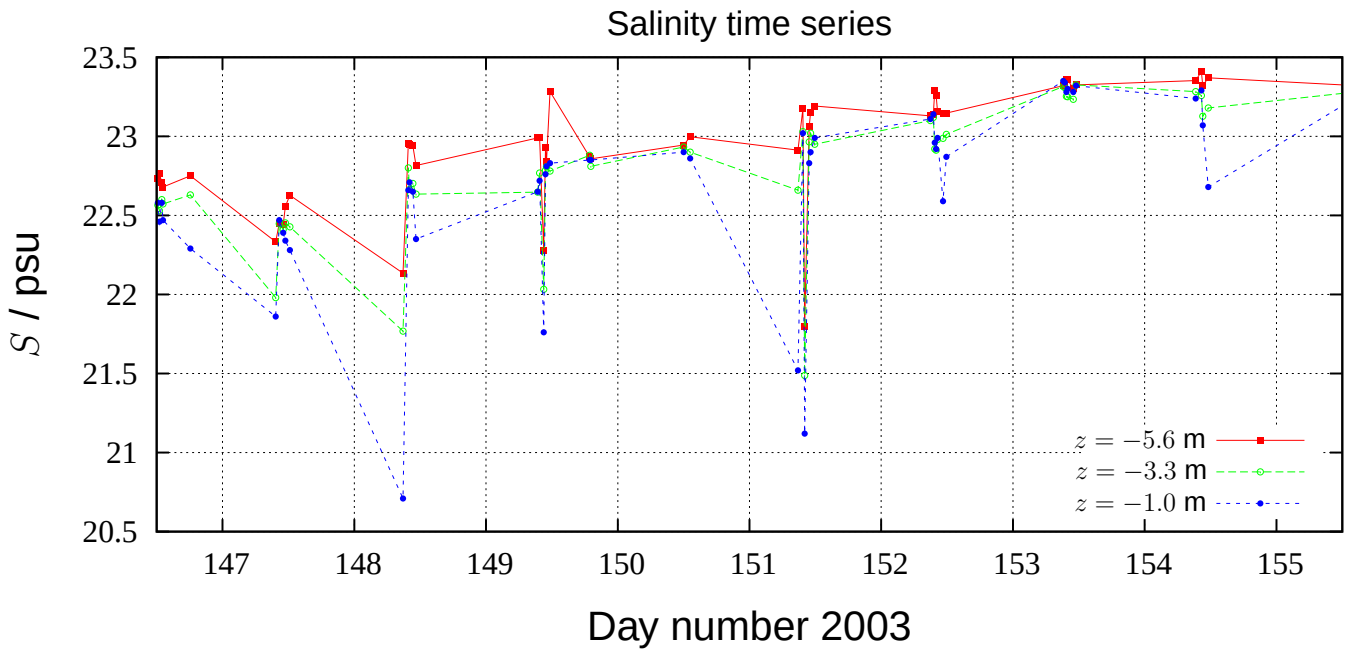
Wind stress reduces stratification.

Wind stress vs. shear



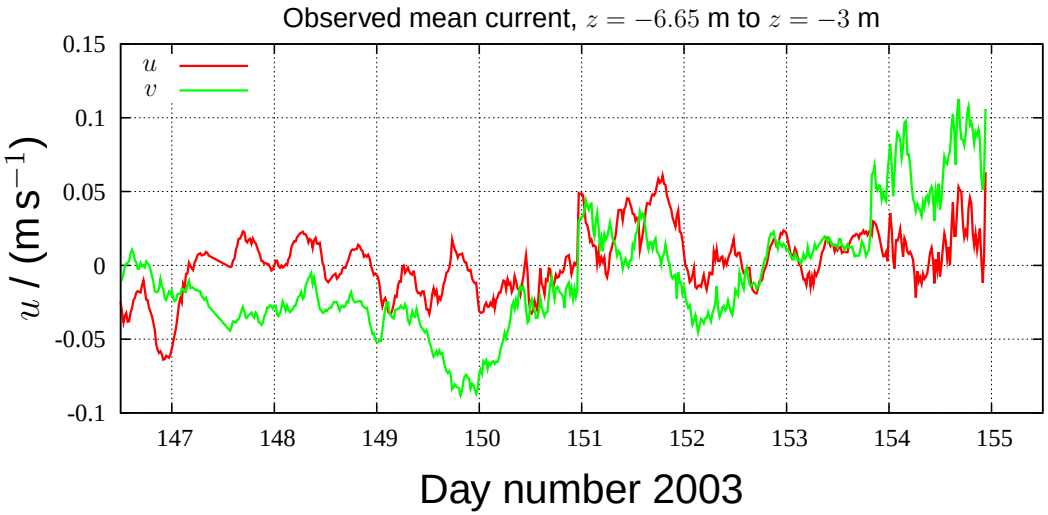
Wind stress reduces shear.

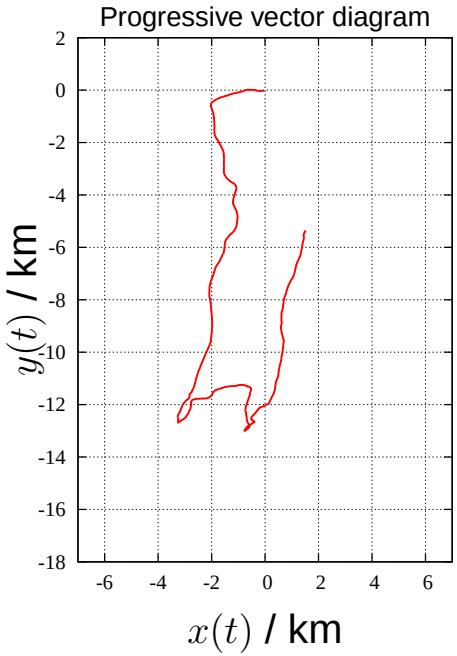
Salinity tendency



Mean salinity is increasing.

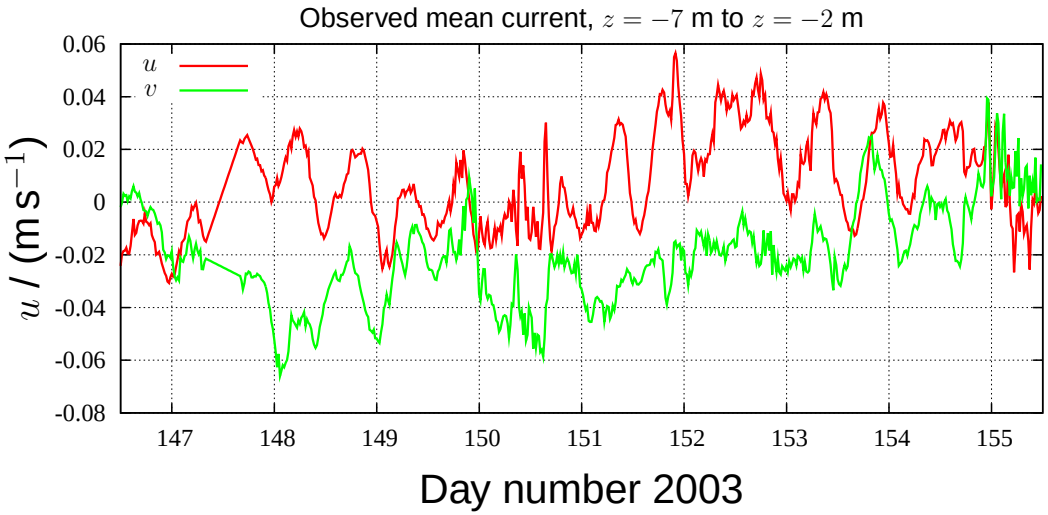
Sand station: Current direction

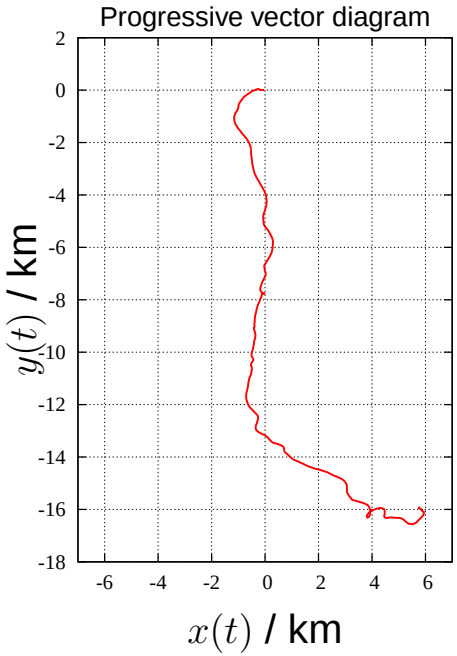




Mean current is moving southward.

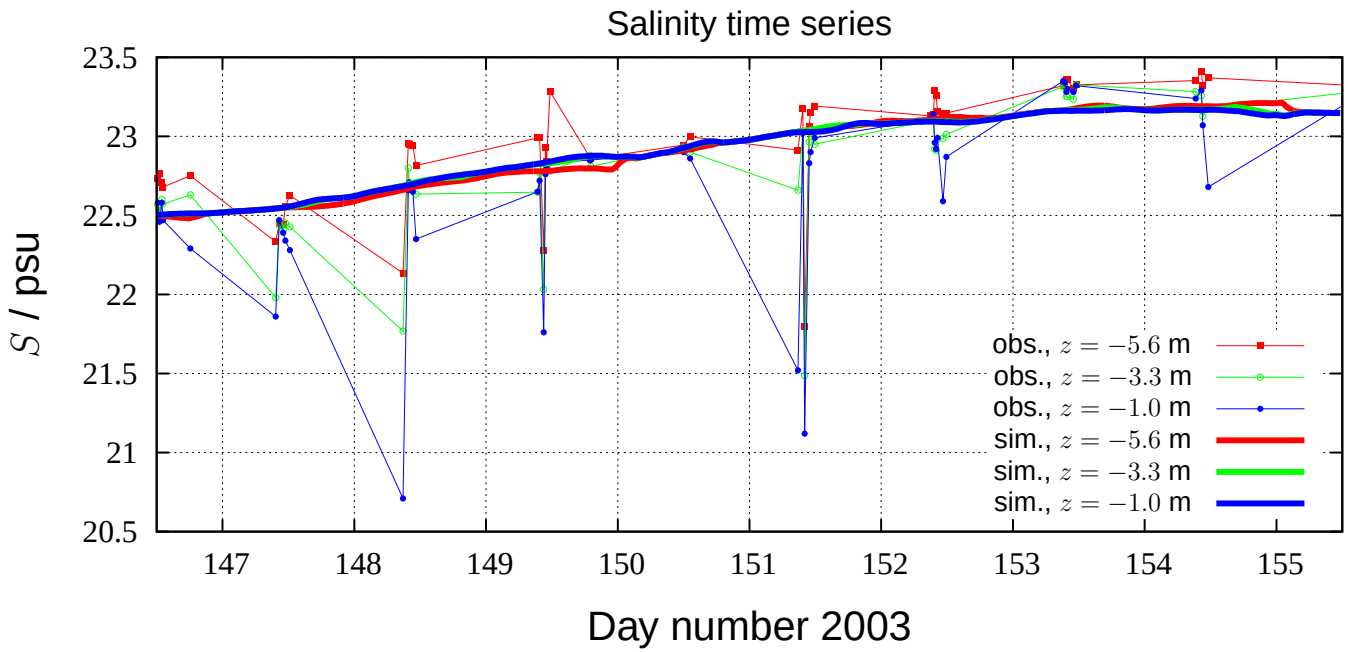
Mussel station: Current direction





Mean current is moving southward.

Simulated salinity tendency



Mean salinity is increasing.

GOTM, http://www.gotm.net

- Challenge
- Aim
- The Idea
- Key features
- Software
- Fortran code
- Test cases
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General Ocean Turbulence Model

GOTM is a one-dimensional numerical model developed and supported by a core team of ocean modellers. GOTM aims at simulating accurately vertical exchange processes in the marine environment where mixing is known to play a key role. GOTM is freely available under the GPL (Gnu Public License).

The interested user can download the source code, a set of test cases (Papa, November, Flex, ...) and a comprehensive report.

You are warmly invited to join the GOTM mailing list and send any comments/questions to the GOTM team or become a GOTM contributor. The GOTM developers are grateful to their sponsors.

Page "www.gotm.net" maintained by webmaster. Last update: 10/28/00 18:10:02

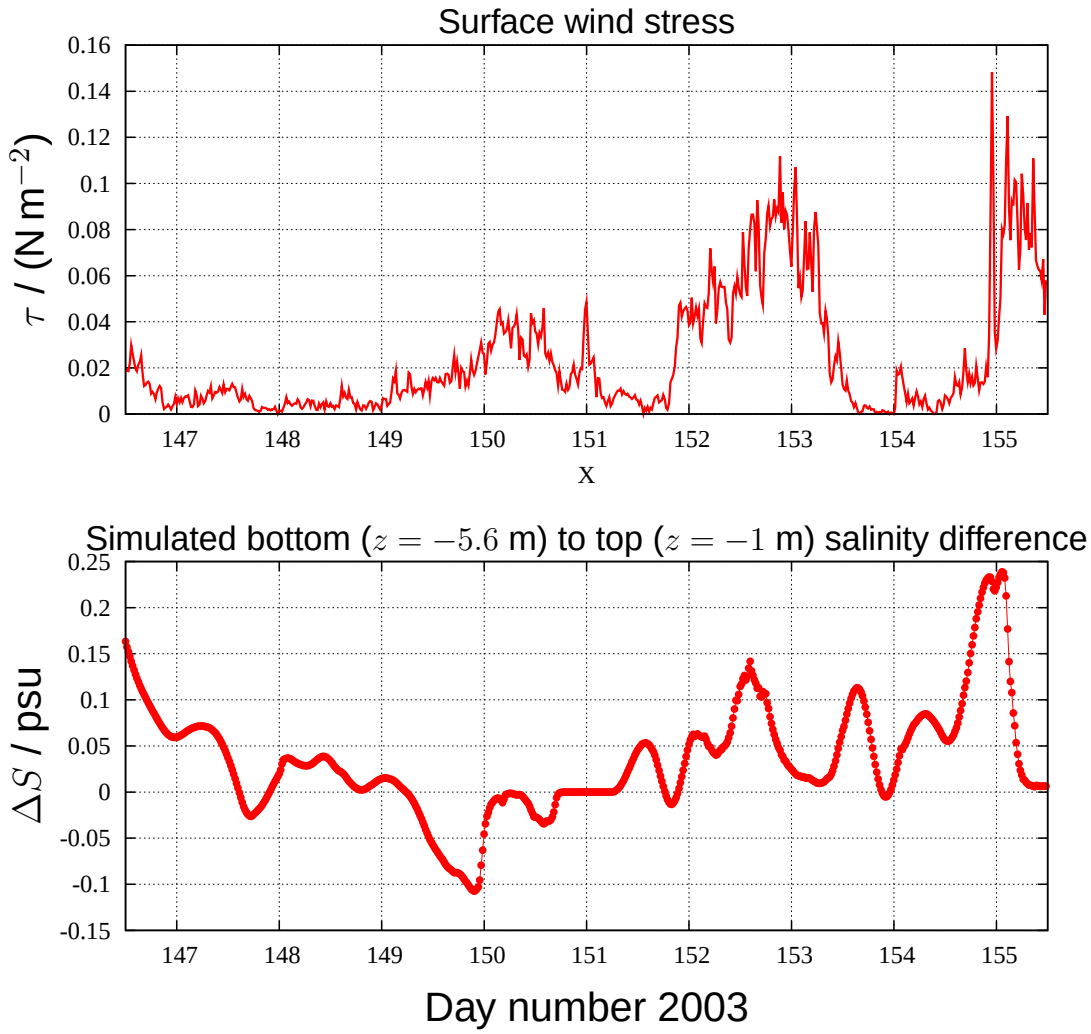
Setup with GOTM

- Location: 56.9369 N, 9.15895 E (middle station)
- Period: May 27, 12:00 pm – June 5, 12:00 pm (2003)
- Water depth: 8 m
- Forcing of model by:
  - Surface fluxes of momentum and heat (from meteo station on Livø)
  - Short wave radiation (from meteo sttaion on Livø)
  - Barotropic pressure gradient (estimated from observed vertical mean flow)
  - Horizontal salinity gradient (estimated from observed mean salinity increase)
  - Discretisation: vetical increment: $\Delta z = 0.1$ m

Processes

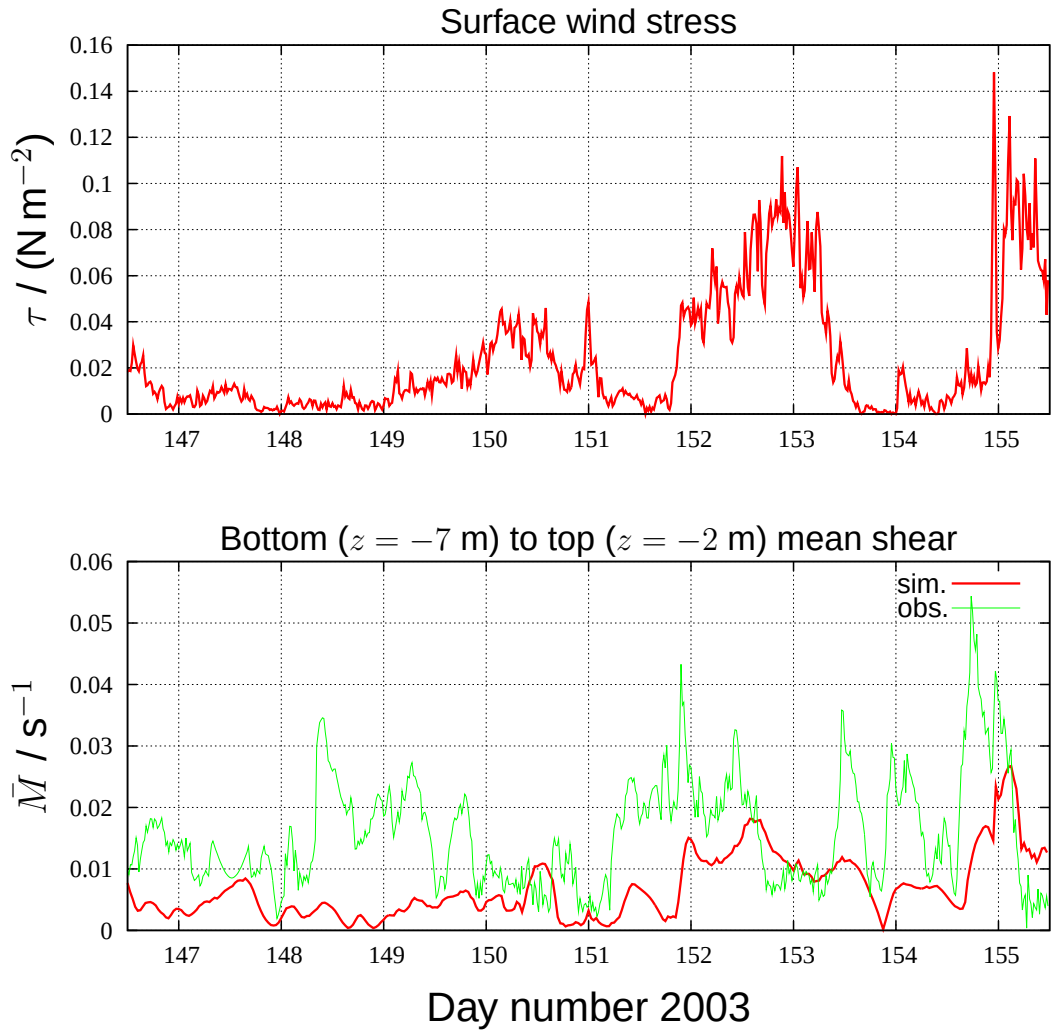
- Processes considered:
  - Internal friction: k-ε model with Canuto et al. [2001] second-moment closure adapted by Burchard and Bolding [2001].
  - Bed friction
  - Rotation
  - Stratification
  - Internal and external pressure gradients
  - Advection of salt
- Processes not considered:
  - Surface waves
  - Most 3D effects

Wind stress vs. sim. stratification



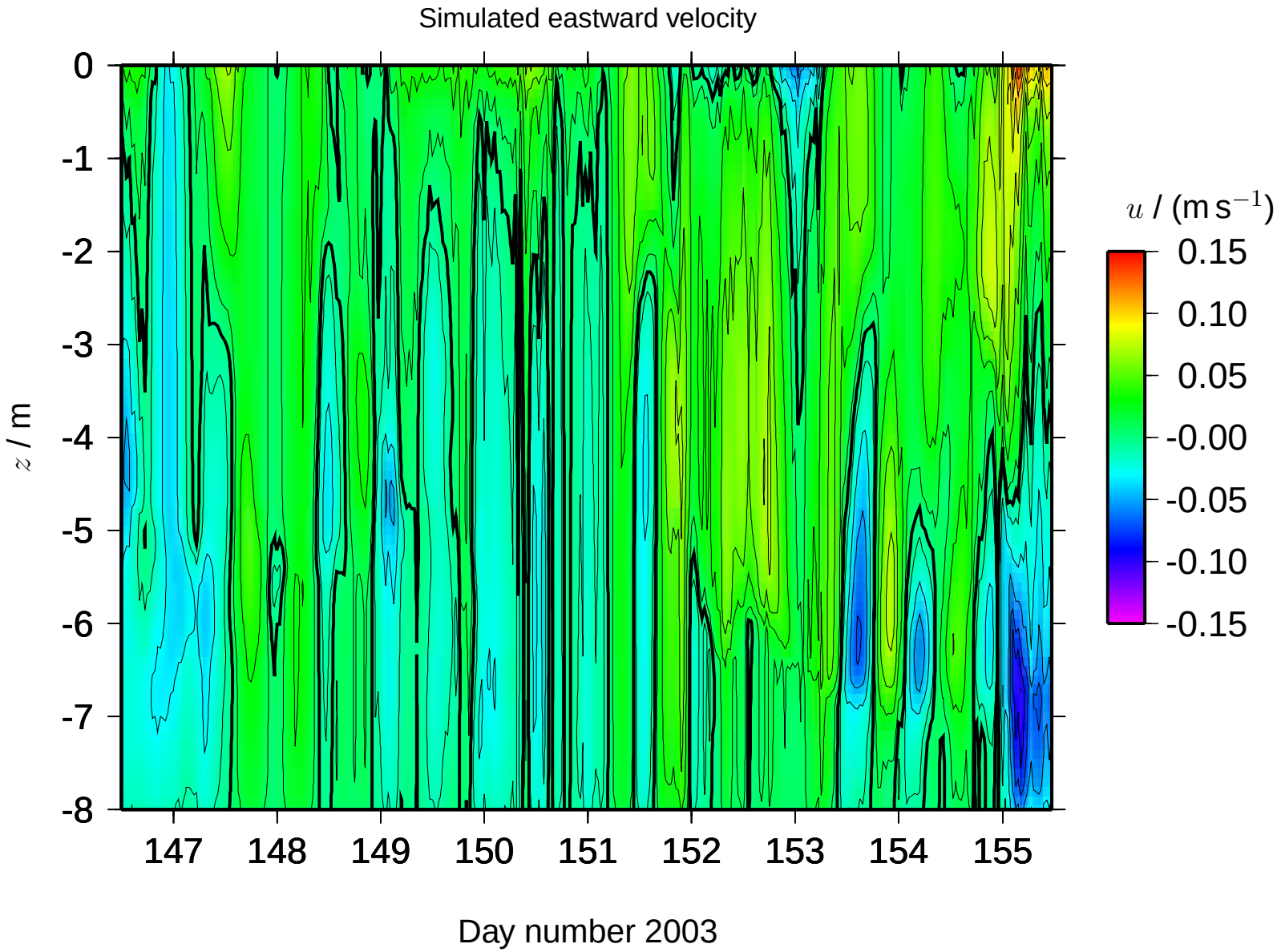
Wind stress reduces stratification.

Wind stress vs. simulated shear

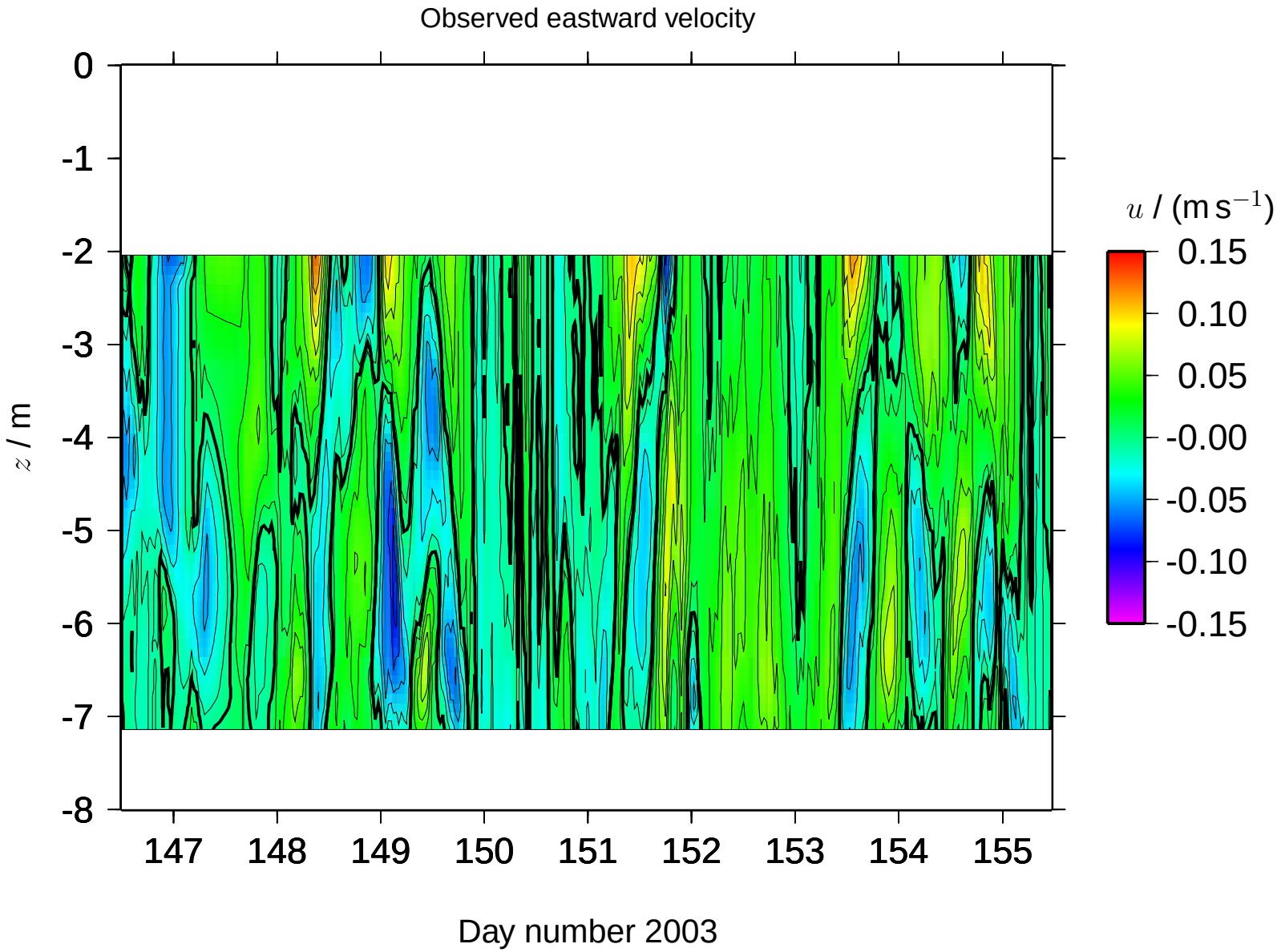


Wind stress reduces shear.

Simulated eastward velocity

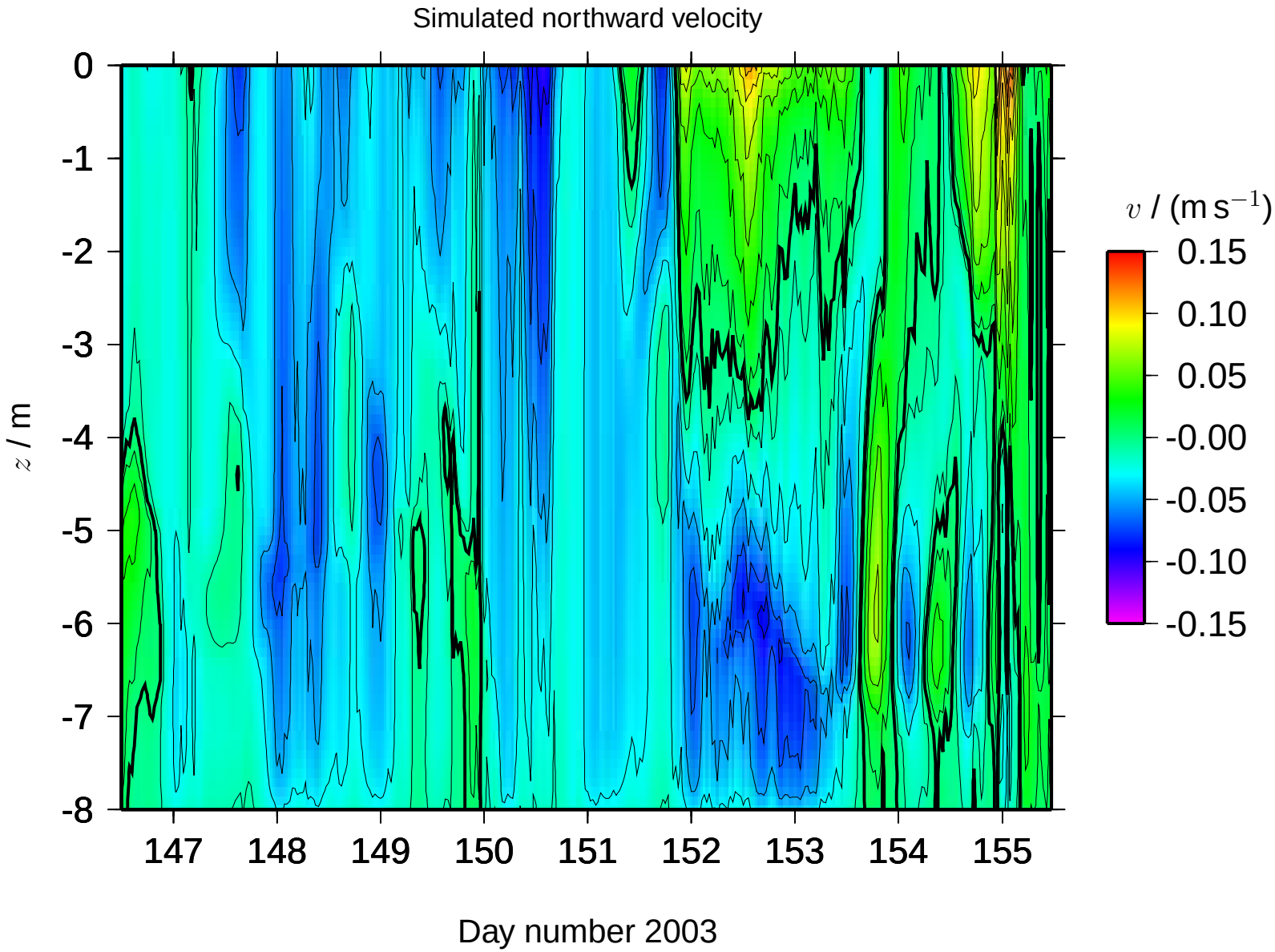


Observed eastward velocity

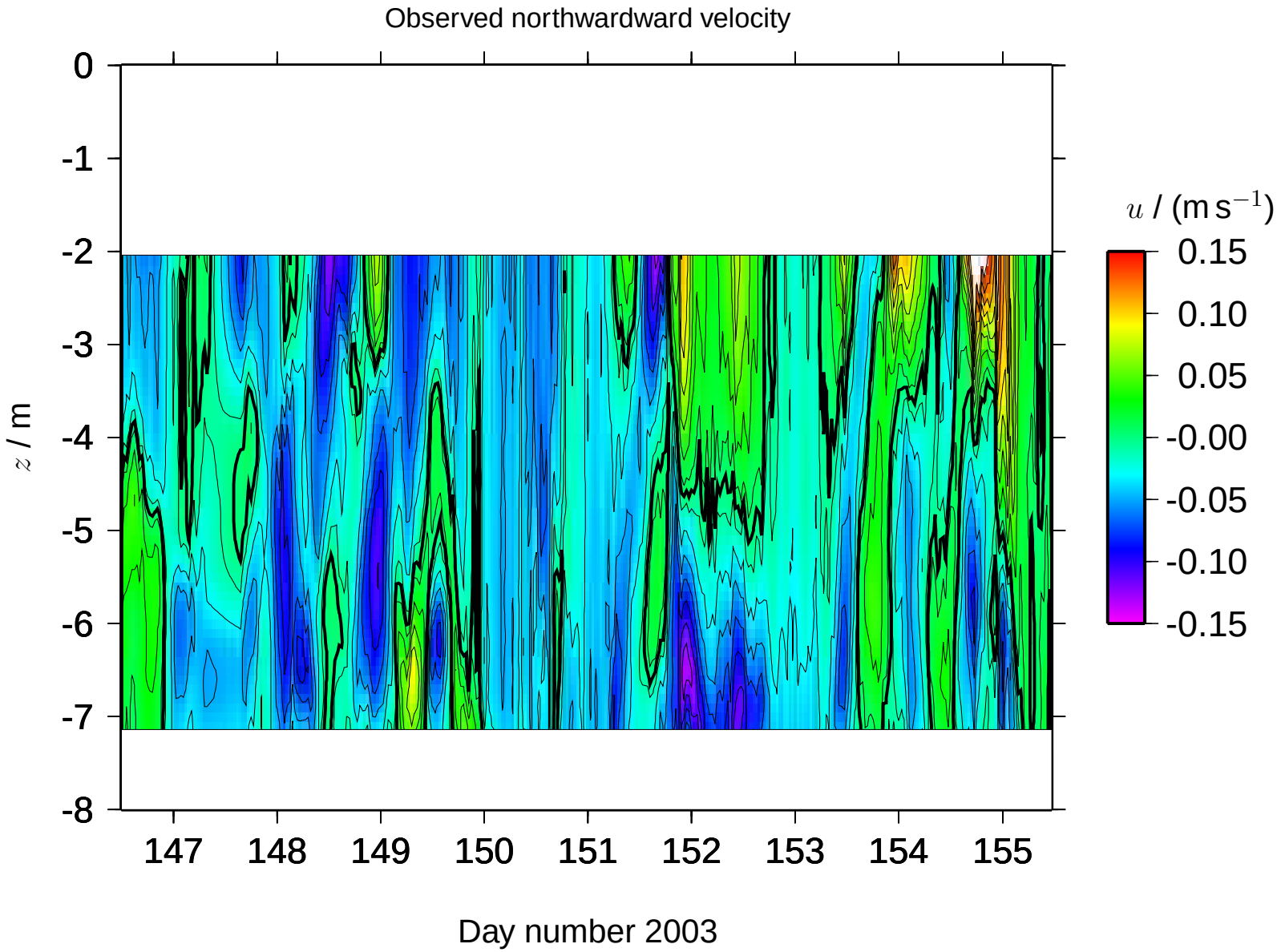


ADCP data from School of Ocean Sciences, Bangor, Wales

Simulated northward velocity

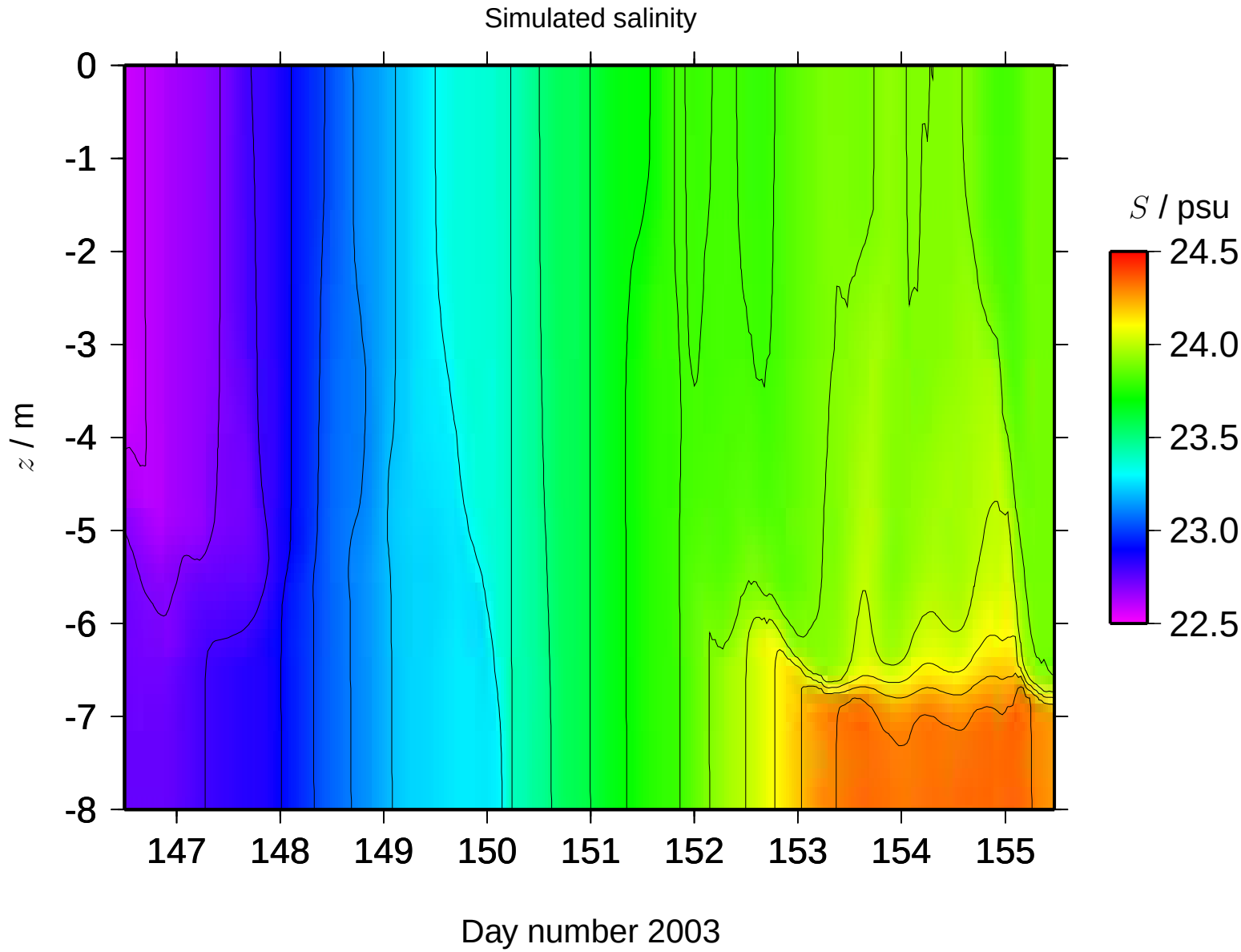


Observed northward velocity

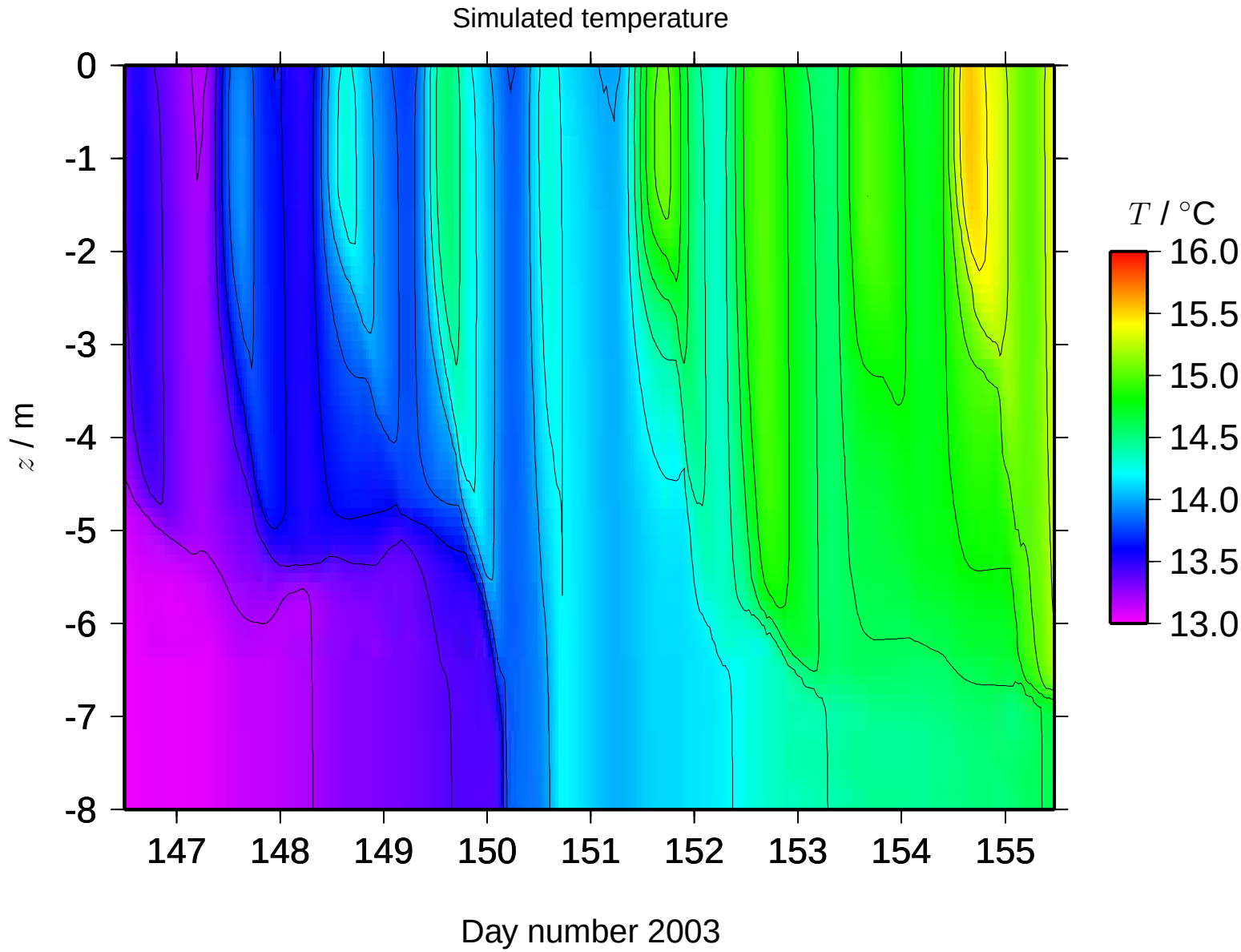


ADCP data from School of Ocean Sciences, Bangor, Wales

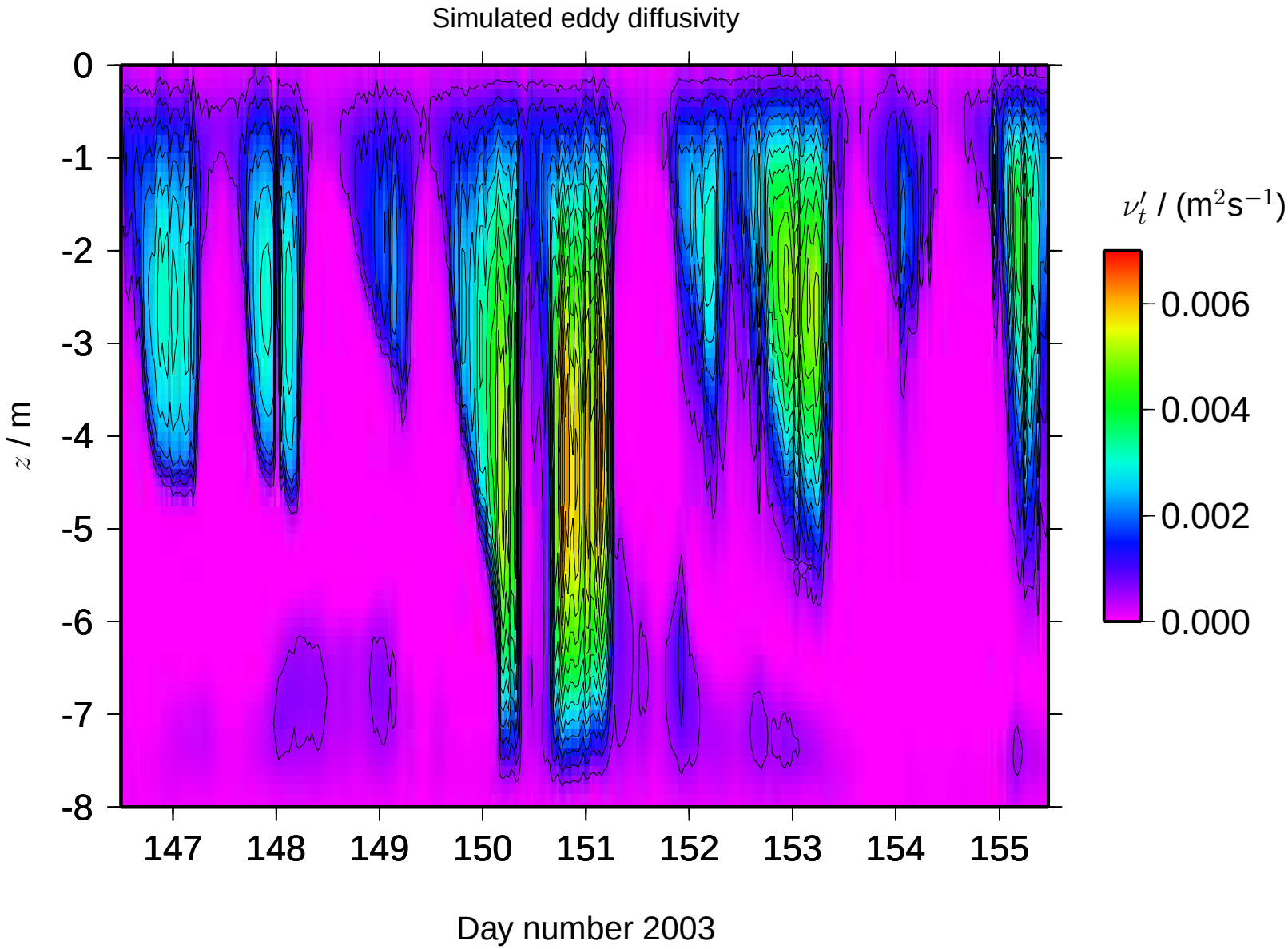
Simulated salinity



Simulated temperature

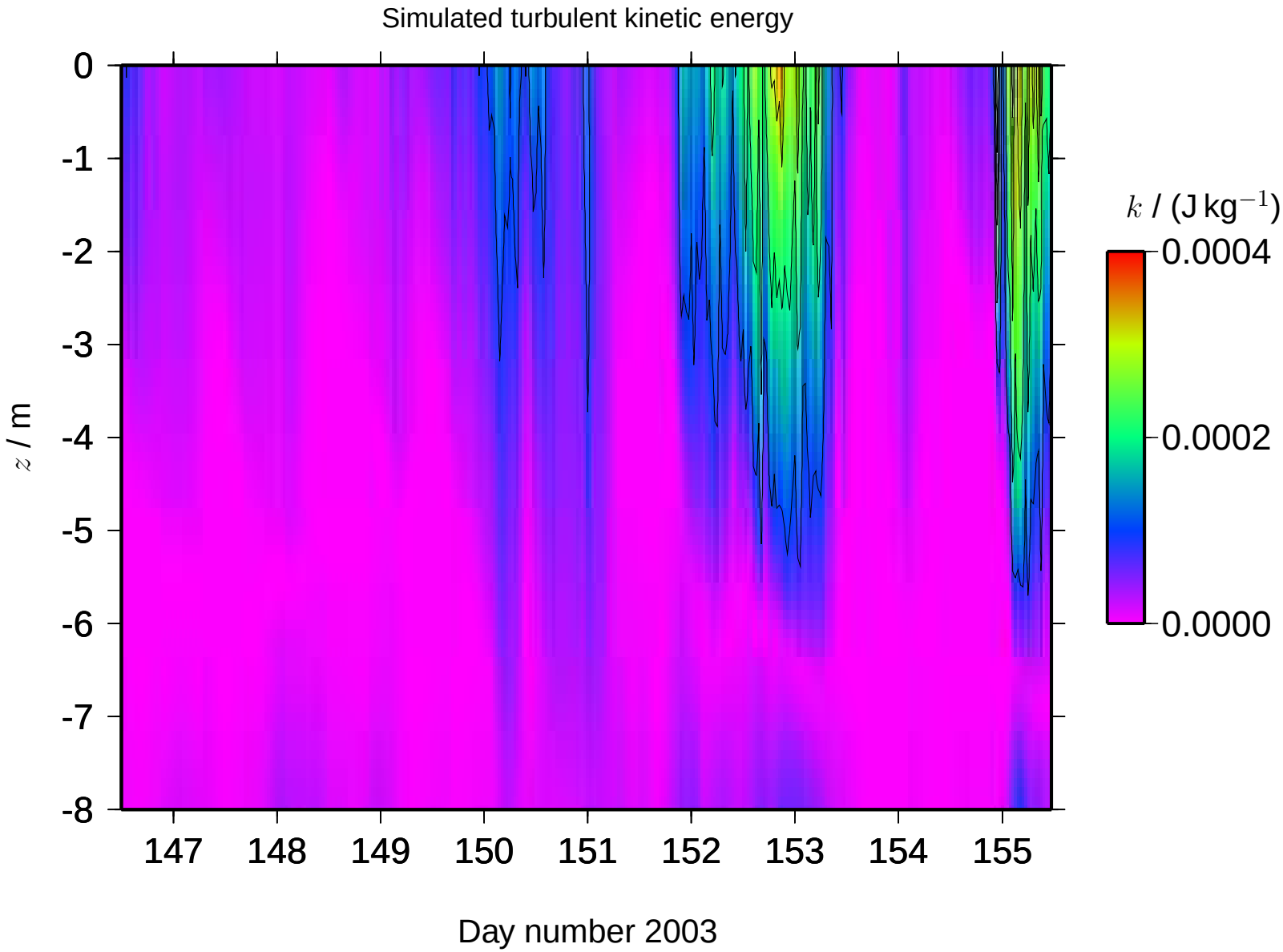


Simulated eddy diffusivity



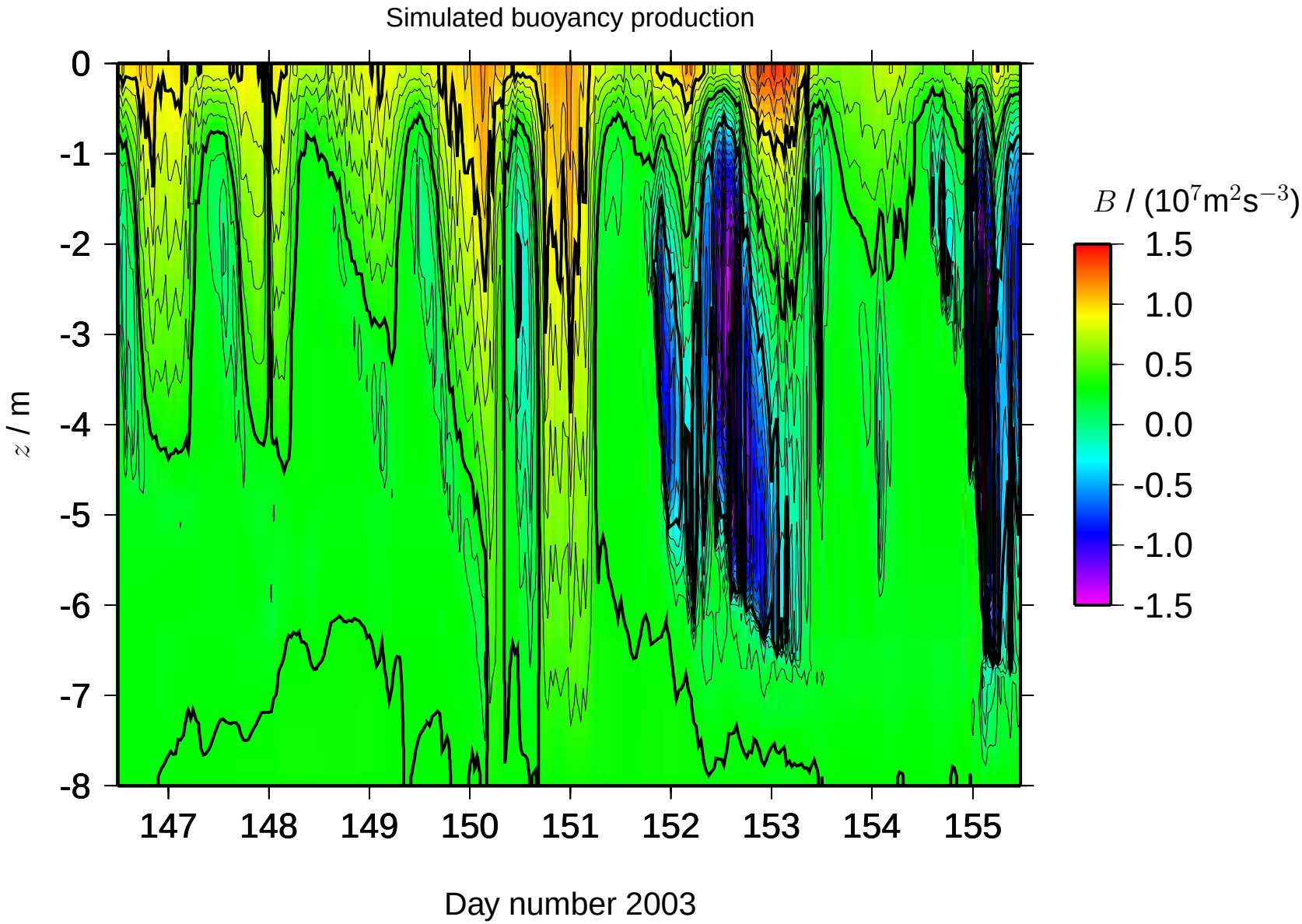
k-ε model with Canuto et al. [2001] algebraic second-moment closure

Simulated turbulent kinetic energy



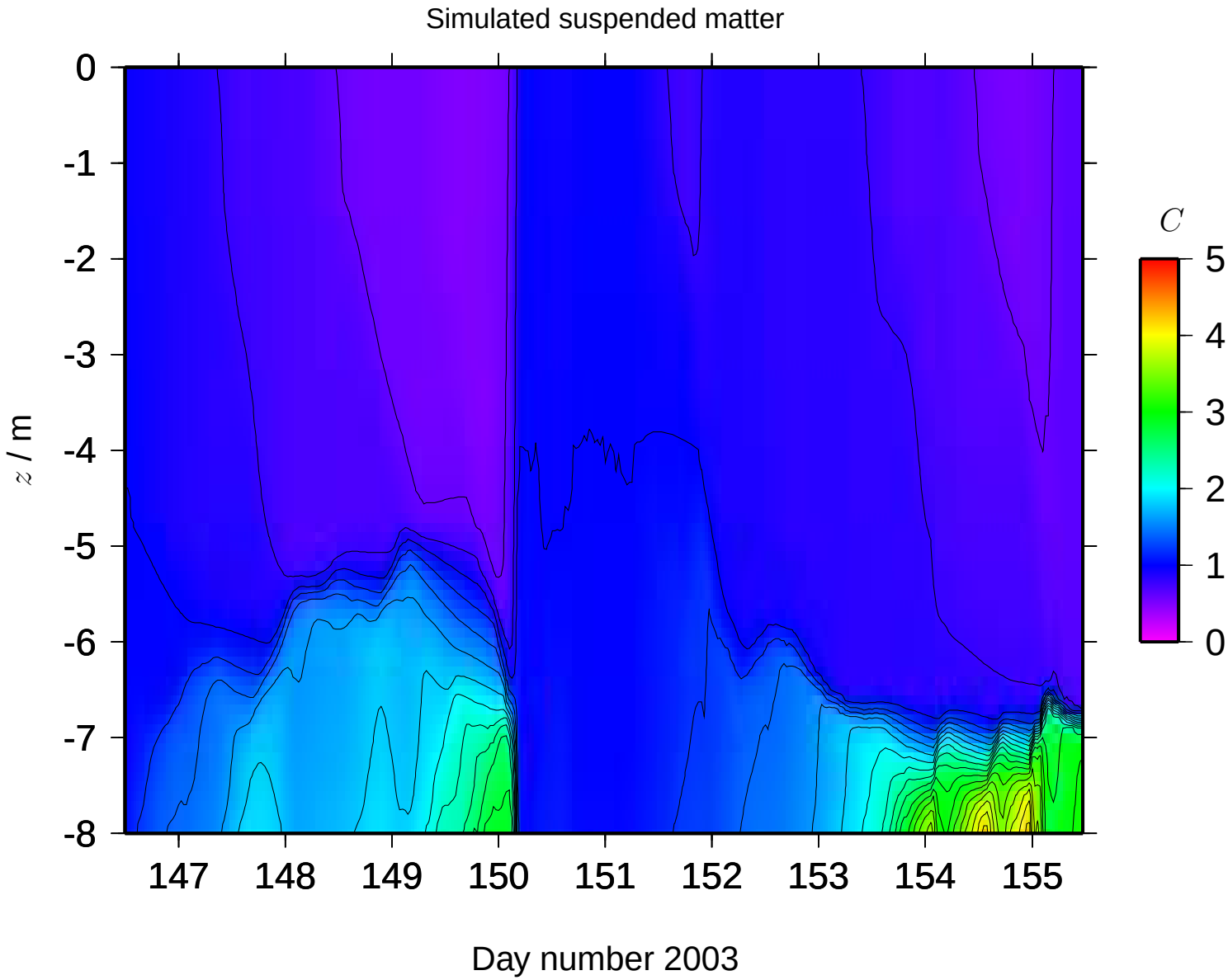
k-ε model with Canuto et al. [2001] algebraic second-moment closure

Simulated buoyancy production



k-ε model with Canuto et al. [2001] algebraic second-moment closure

Simulated suspended matter



No sinks, no sources, settling velocity: $w_s = 1\ \mathrm{m\,d^{-1}}$

Conclusions

- Even with a 1D model, the complex dynamics of estuaries may be quantitatively reproduced on short time scale (if good observations are available).
- Details have to be investigated more carefully such as underestimation of shear, direction of mean flow and horizontal salt gradient, local surface fluxes, etc.
- The role of surface waves on mixing needs careful consideration: Do we need to model them ?
- The ability of the model to reproduce the Simpson theoretical work on competition between stratifying and destratifying forces should be challenged.
- The suspended matter dynamics needs more realistic treatment (initial conditions, advection, grazing by mussels).