High resolution modelling of the Baltic Proper

Germo Väli, Markus Meier, Hagen Radtke

Acknowledgments: Knut Klingbeil & Ulf Gräwe, HLRN for CPUtime

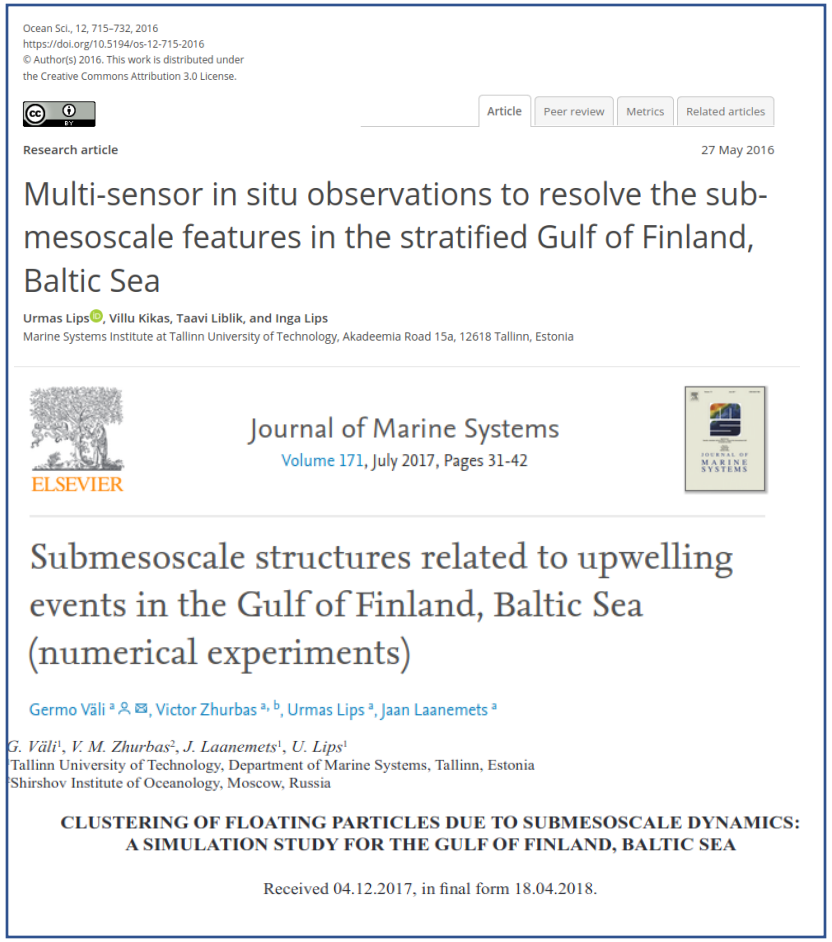
2nd Baltic Model Intercomparison (BMIP) workshop 09.04.2021

Outline

- Background and motivation
- Model description
- Some results

BG and motivation

- Interest in TalTech started in 2013. when Urmas Lips got a 1st grant for studying submesoscale processes in the Baltic Sea.



Ocean Sci., 12, 715–732, 2016
https://doi.org/10.5194/os-12-715-2016
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Research article — 27 May 2016

Multi-sensor in situ observations to resolve the sub-mesoscale features in the stratified Gulf of Finland, Baltic Sea

Urmas Lips, Villu Kikas, Taavi Liblik, and Inga Lips
Marine Systems Institute at Tallinn University of Technology, Akadeemia Road 15a, 12618 Tallinn, Estonia

ELSEVIER

Journal of Marine Systems
Volume 171, July 2017, Pages 31-42

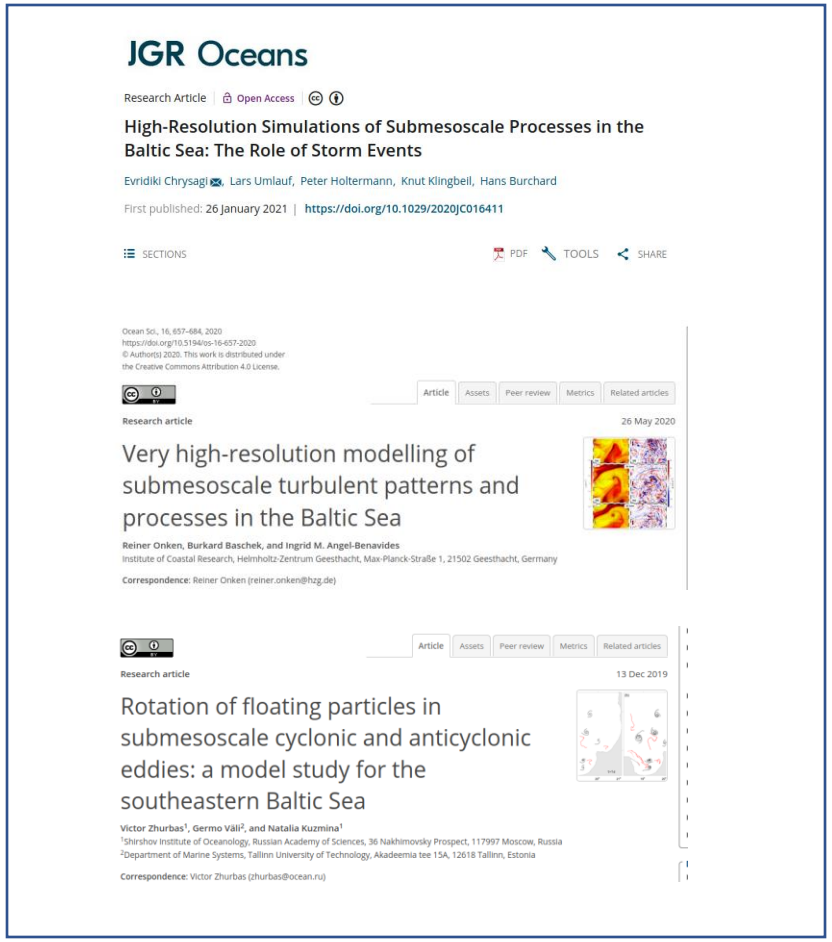
Submesoscale structures related to upwelling events in the Gulf of Finland, Baltic Sea (numerical experiments)

Germo Väli [a], Victor Zhurbas [a, b], Urmas Lips [a], Jaan Laanemets [a]

G. Väli[1], V. M. Zhurbas[2], J. Laanemets[1], U. Lips[1]
[1]Tallinn University of Technology, Department of Marine Systems, Tallinn, Estonia
[2]Shirshov Institute of Oceanology, Moscow, Russia

CLUSTERING OF FLOATING PARTICLES DUE TO SUBMESOSCALE DYNAMICS: A SIMULATION STUDY FOR THE GULF OF FINLAND, BALTIC SEA

Received 04.12.2017, in final form 18.04.2018.



JGR Oceans

Research Article | Open Access

High-Resolution Simulations of Submesoscale Processes in the Baltic Sea: The Role of Storm Events

Evridiki Chrysagi, Lars Umlauf, Peter Holtermann, Knut Klingbeil, Hans Burchard

First published: 26 January 2021 | https://doi.org/10.1029/2020JC016411

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Ocean Sci., 16, 657–684, 2020
https://doi.org/10.5194/os-16-657-2020
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Research article — 26 May 2020

Very high-resolution modelling of submesoscale turbulent patterns and processes in the Baltic Sea

Reiner Onken, Burkard Baschek, and Ingrid M. Angel-Benavides
Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Max-Planck-Straße 1, 21502 Geesthacht, Germany

Correspondence: Reiner Onken (reiner.onken@hzg.de)

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Research article — 13 Dec 2019

Rotation of floating particles in submesoscale cyclonic and anticyclonic eddies: a model study for the southeastern Baltic Sea

Victor Zhurbas[1], Germo Väli[2], and Natalia Kuzmina[1]
[1]Shirshov Institute of Oceanology, Russian Academy of Sciences, 36 Nakhimovsky Prospect, 117997 Moscow, Russia
[2]Department of Marine Systems, Tallinn University of Technology, Akadeemia tee 15A, 12618 Tallinn, Estonia

Correspondence: Victor Zhurbas (zhurbas@ocean.ru)

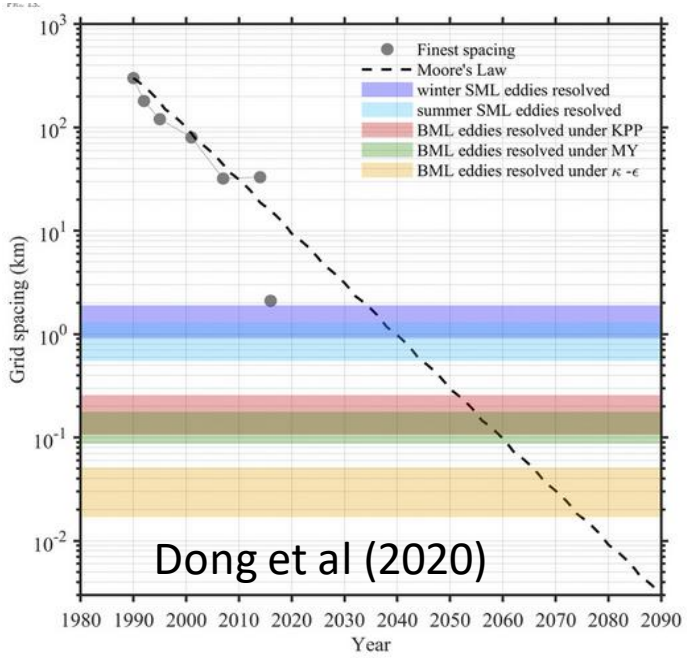
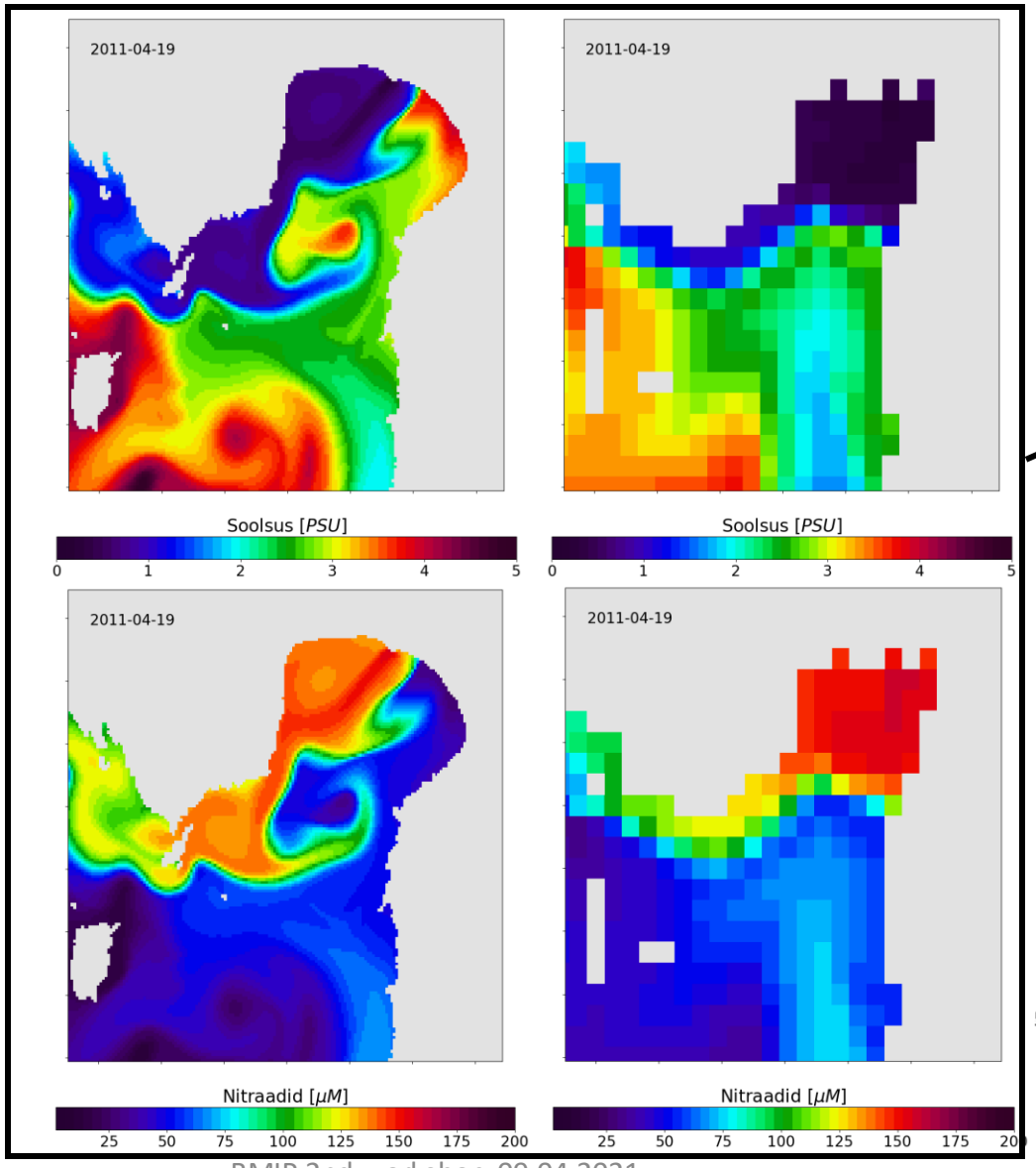
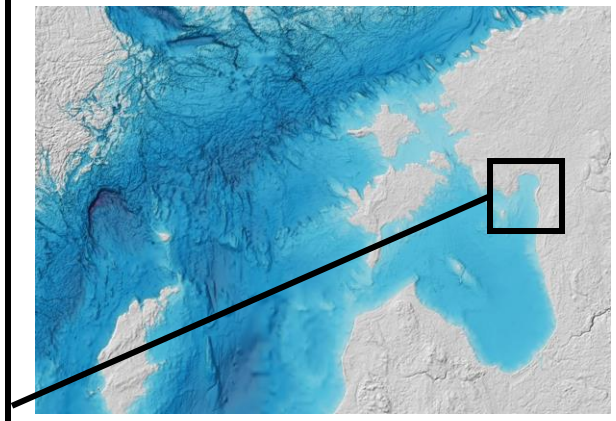
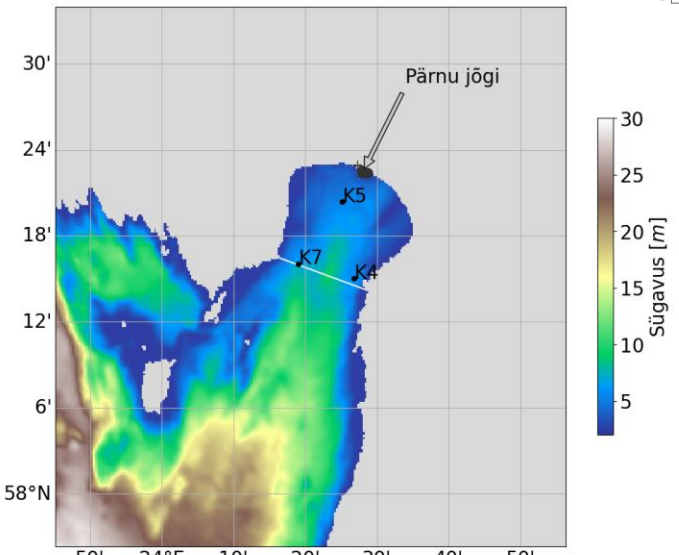


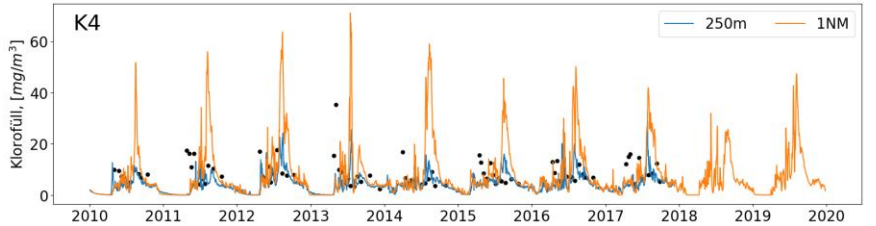
Fig 13: Estimate of horizontal grid spacings of the IPCC ocean models. The gray dots denote the finest grid spacings reported by the IPCC reports by year of publication, except the latest one from the ECCO MITgcm LLC4320 simulation by the publication year of Rocha et al. (2016). The black line denotes the estimate predicted by Moore's Law, while the shaded regions denote the grid spacing intervals resolving 50% and 90% SML eddies globally based on the observations and BML eddies based on simulations.

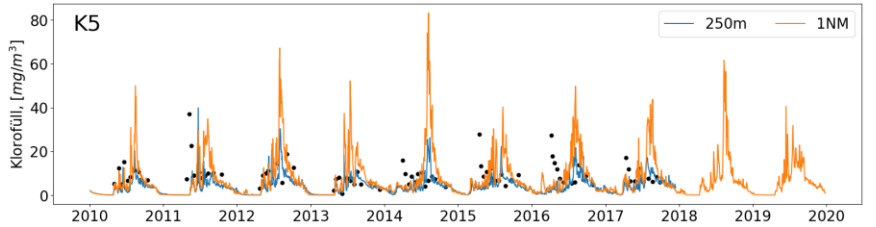
BG and motivation

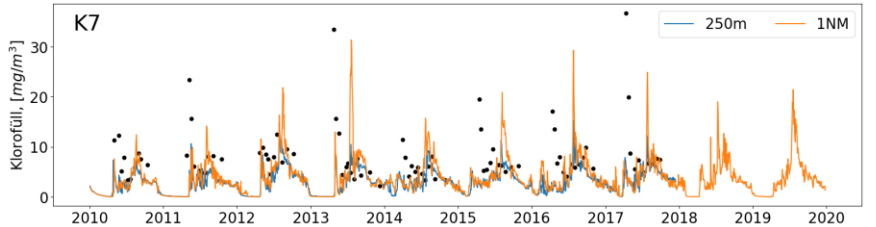


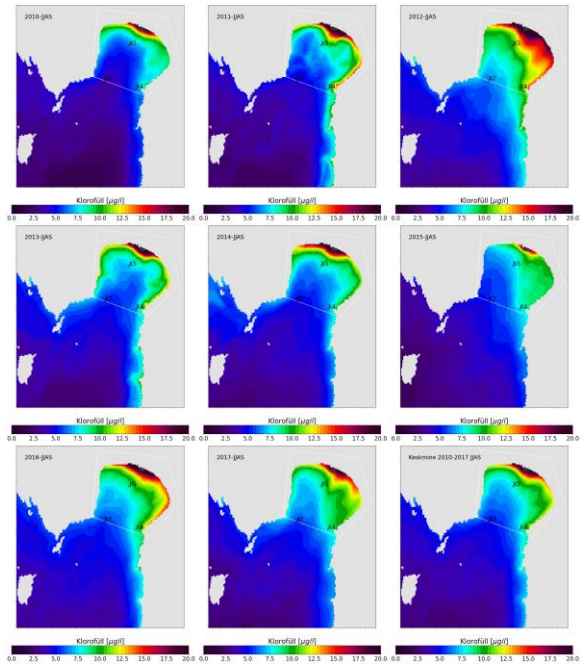






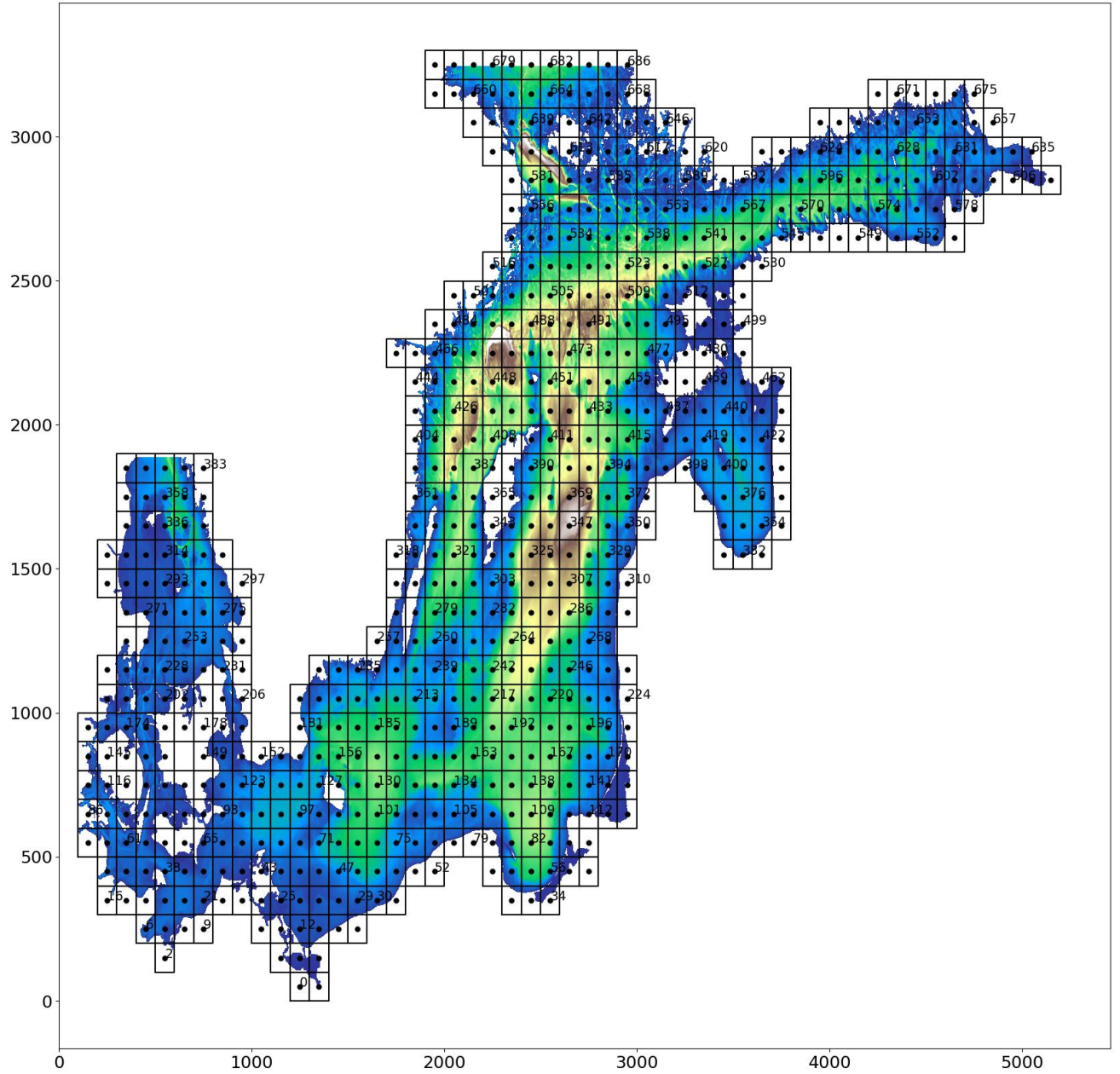




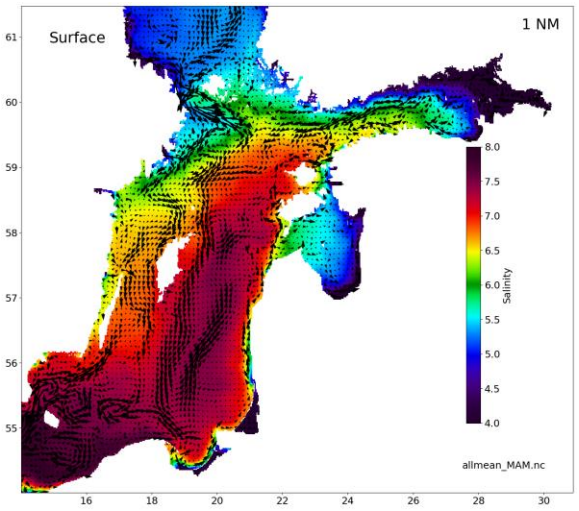


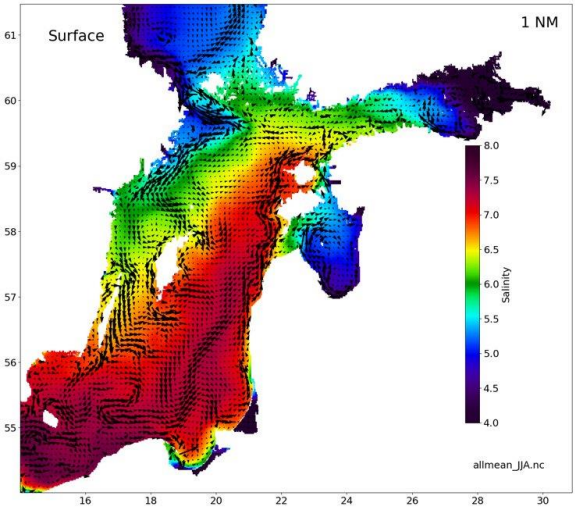
Model description

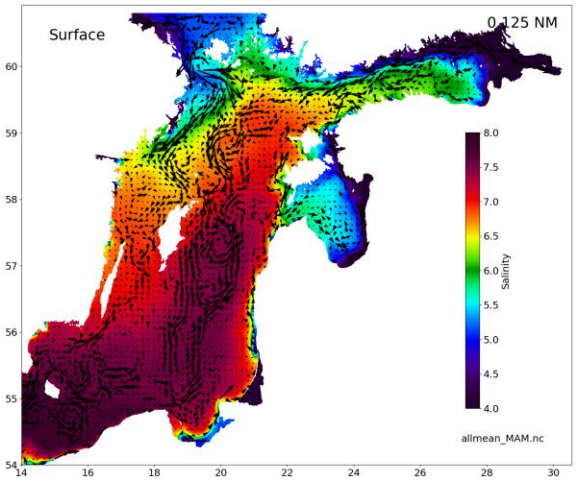
- **GETM**
- Horizontal grid spacing **250m**
- **60** adaptive layers
- Atm. forcing **UERRA**
- BMIP river forcing
- Simulation period **01/2010-11/2012**
- **687** processors, **18** nodes at HLRN
- open boundary conds. **1nm model**

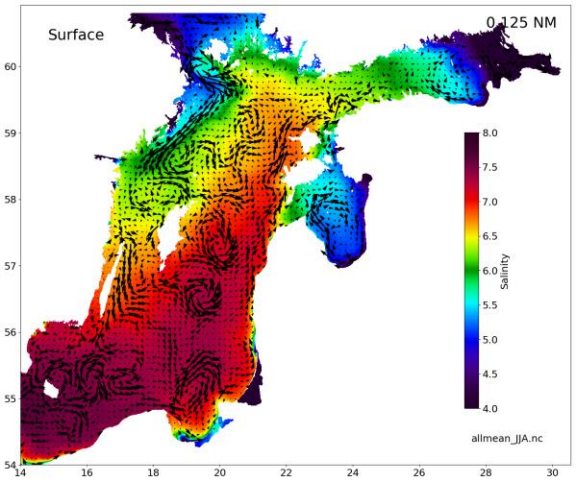


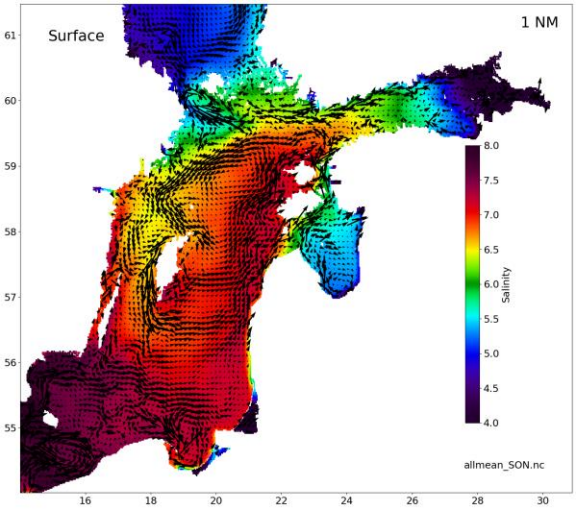
Results: general circulation. Averages 2010-2012

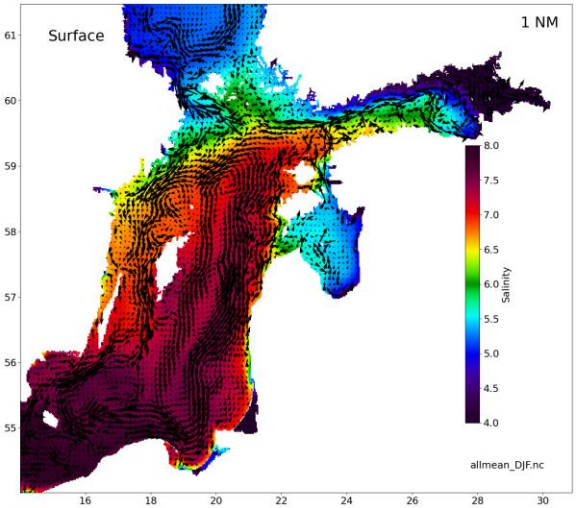


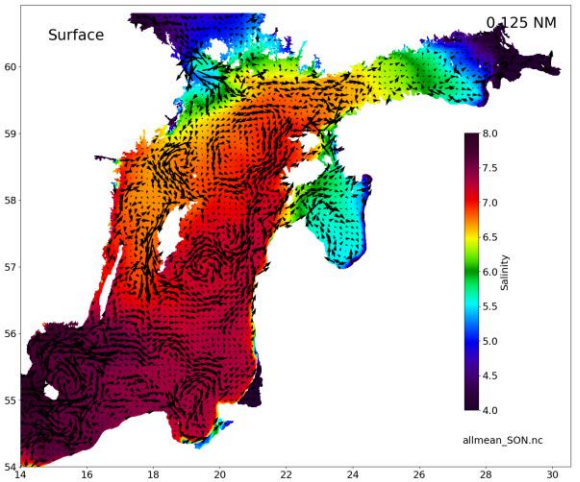


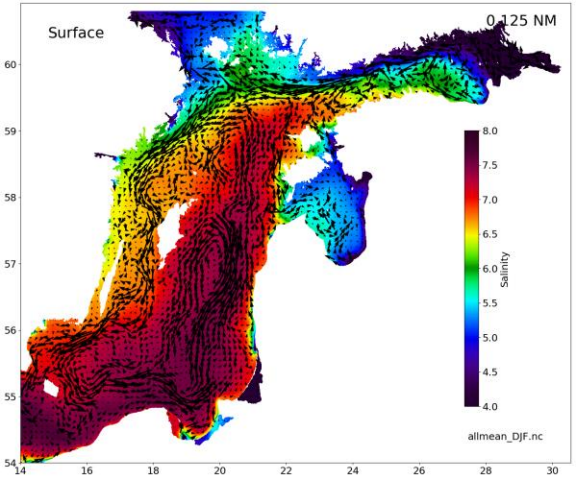












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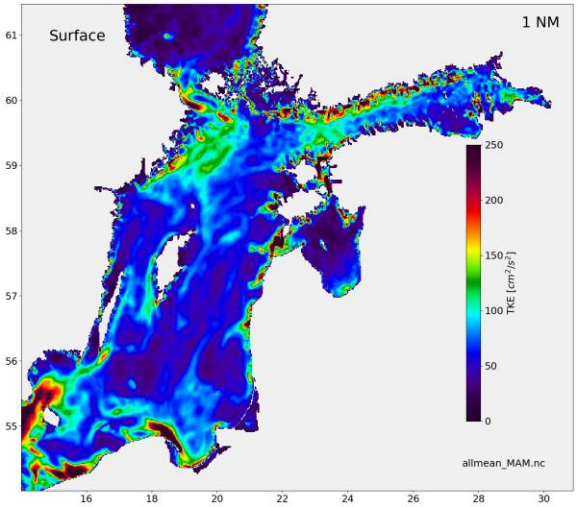

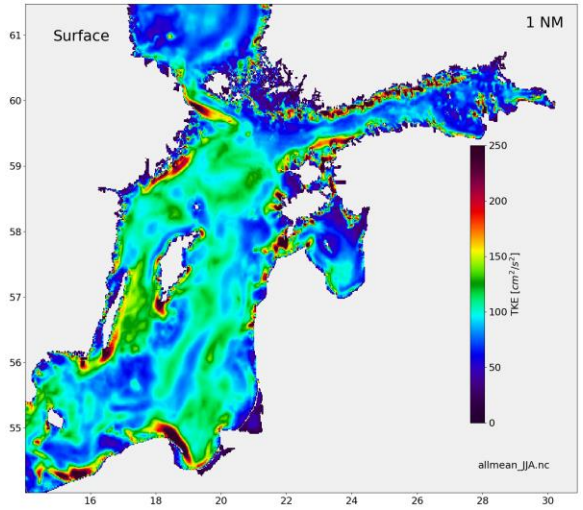

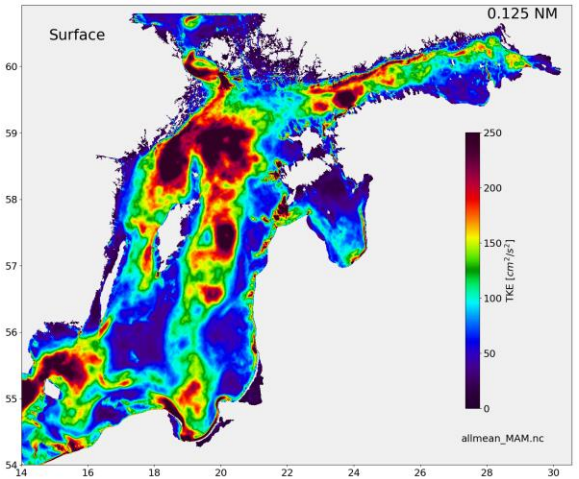

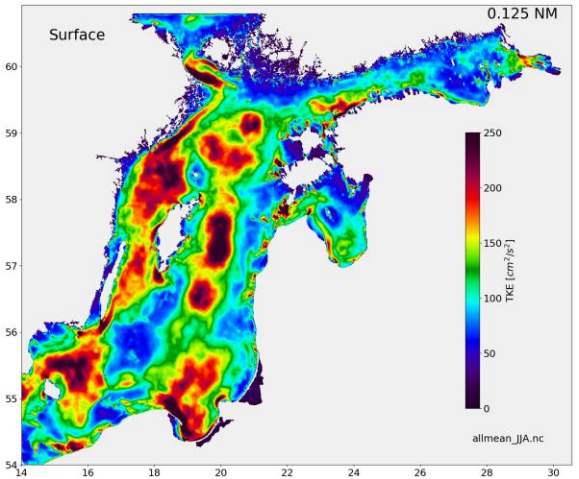

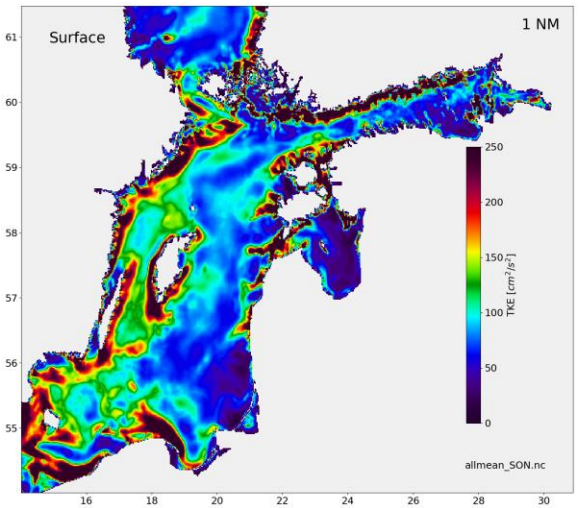

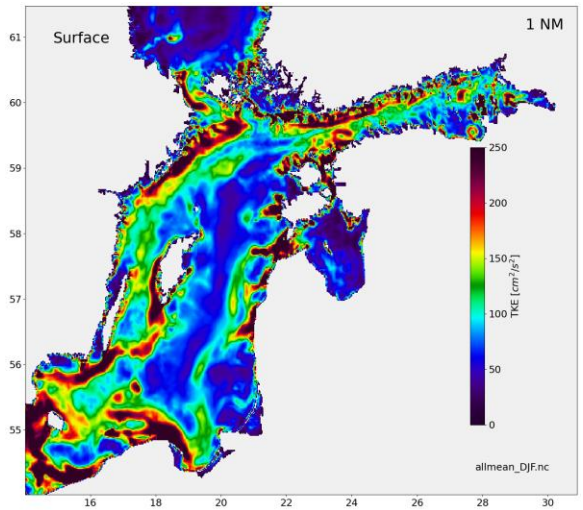

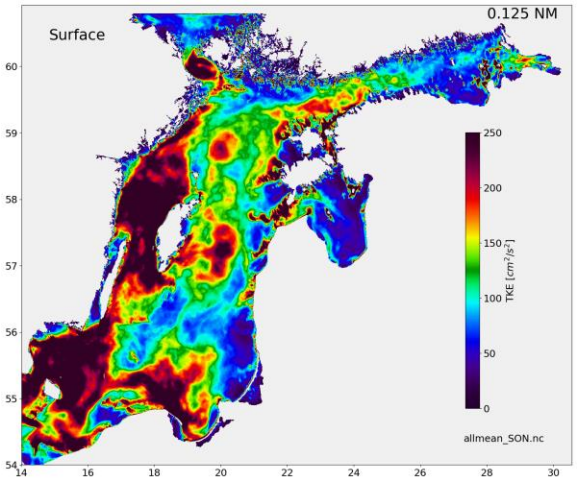

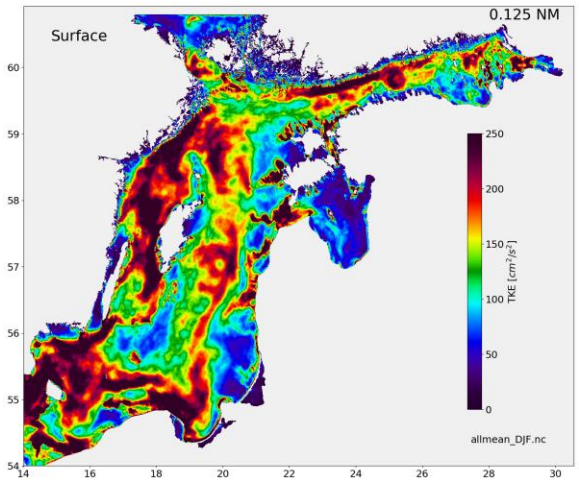

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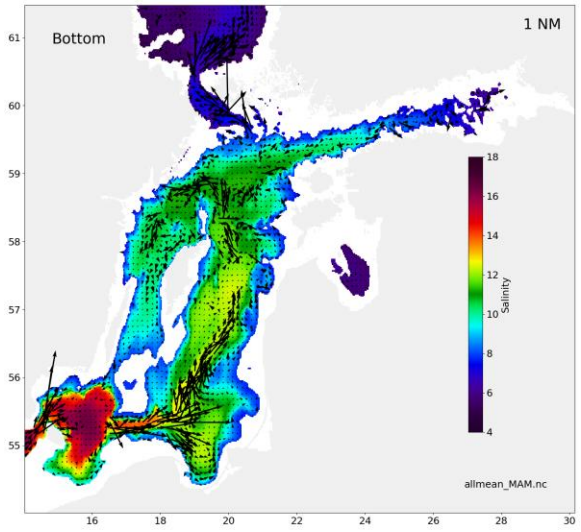
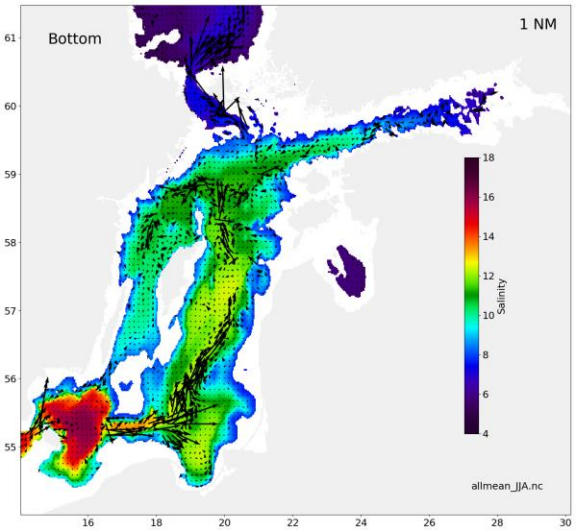
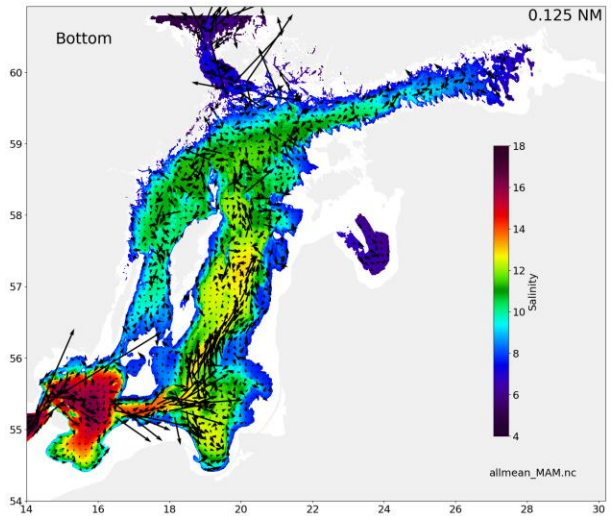
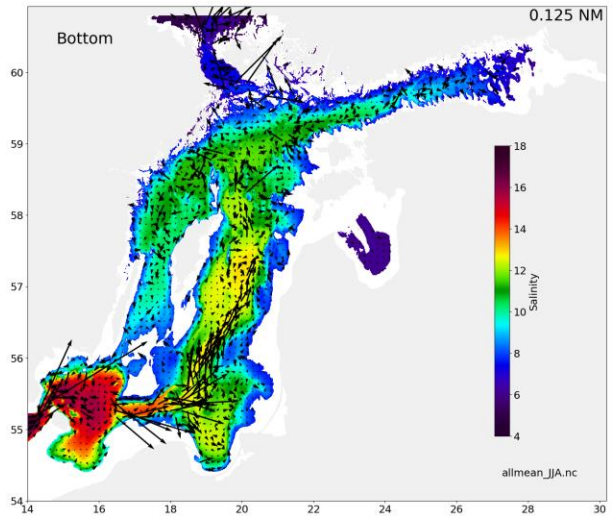
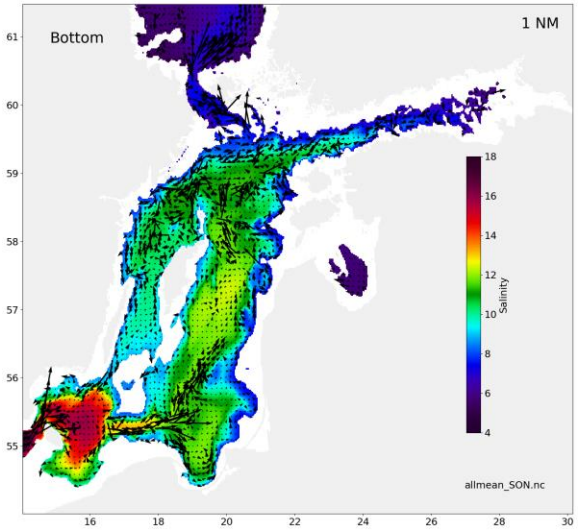
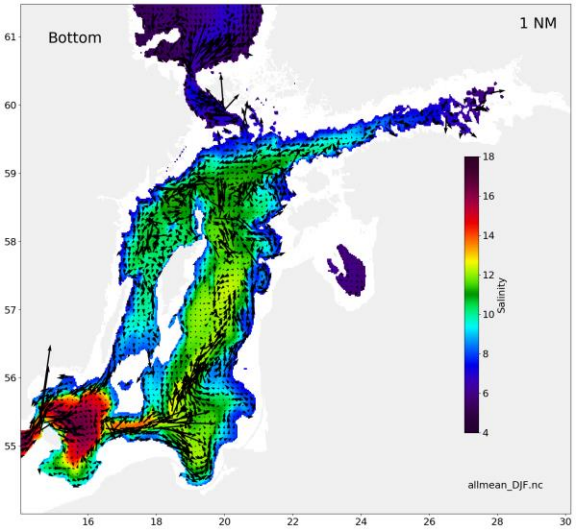


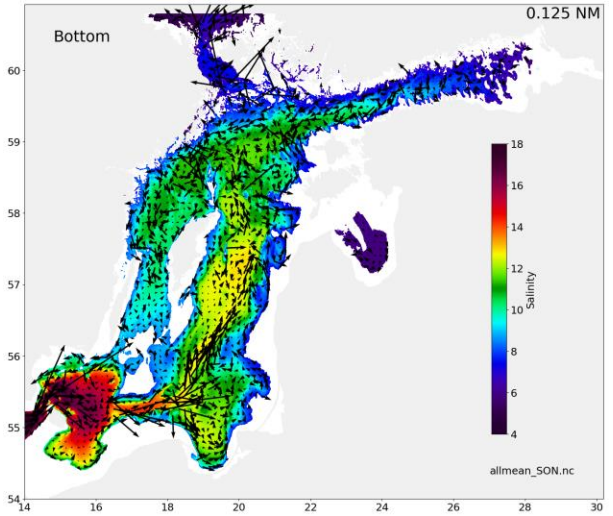


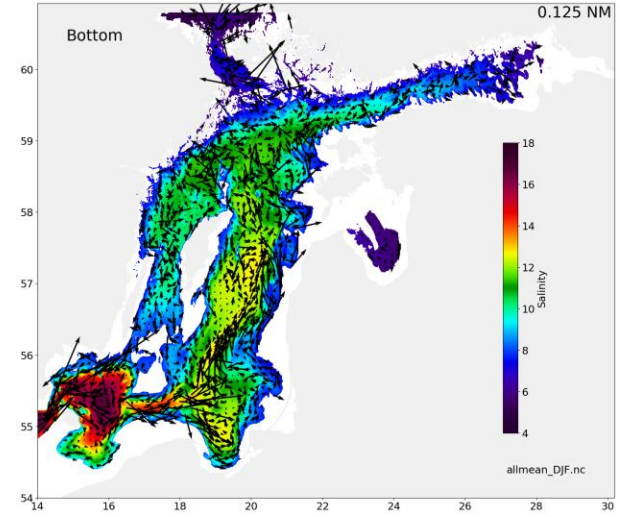




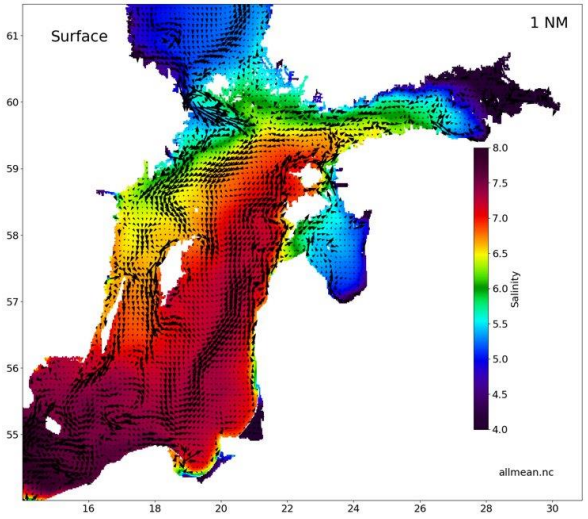


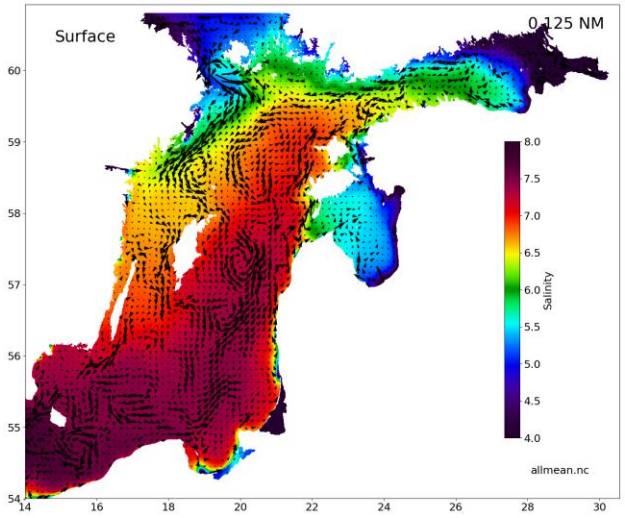


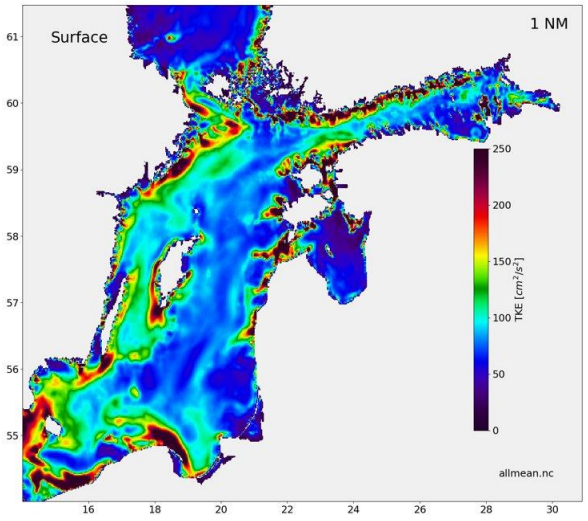


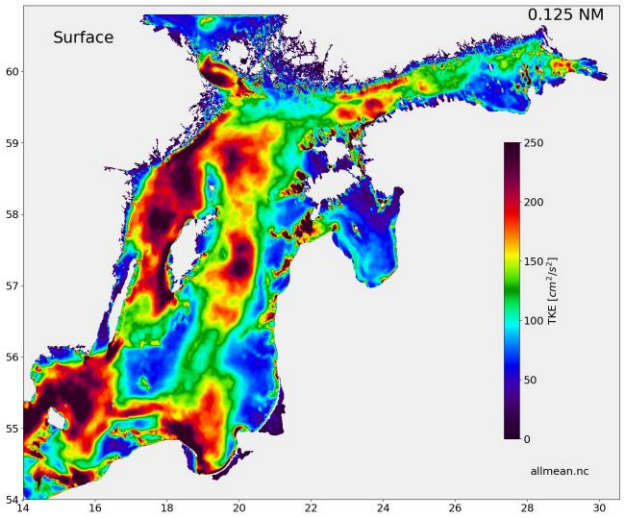


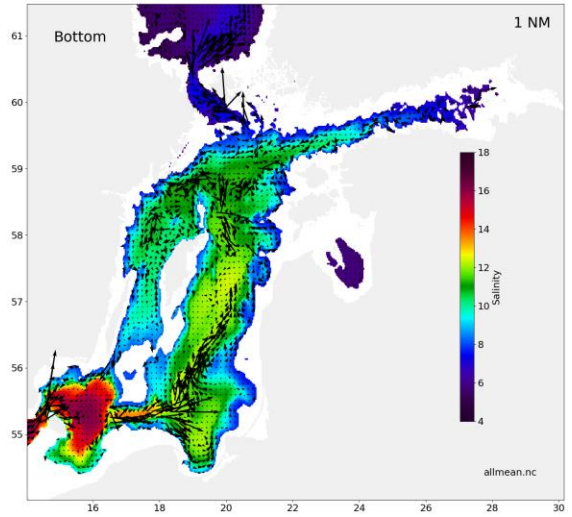
Results: general circulation. Averages 2010-2012

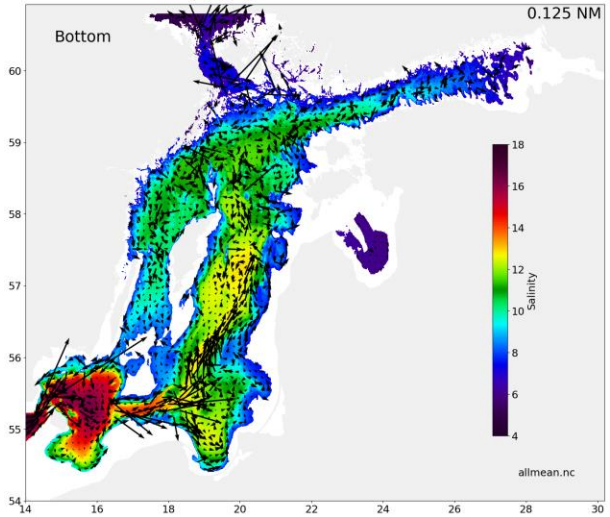






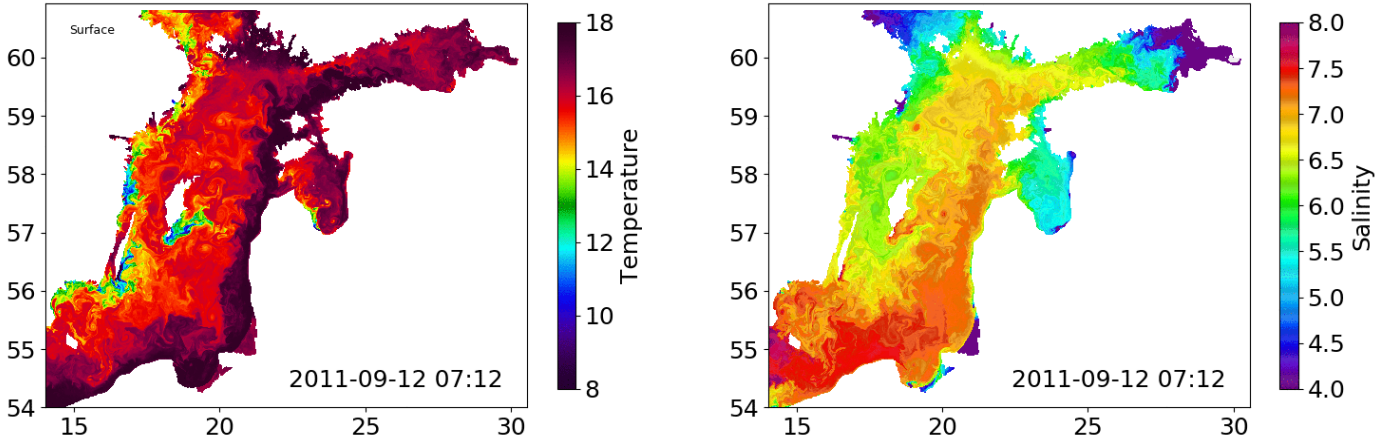




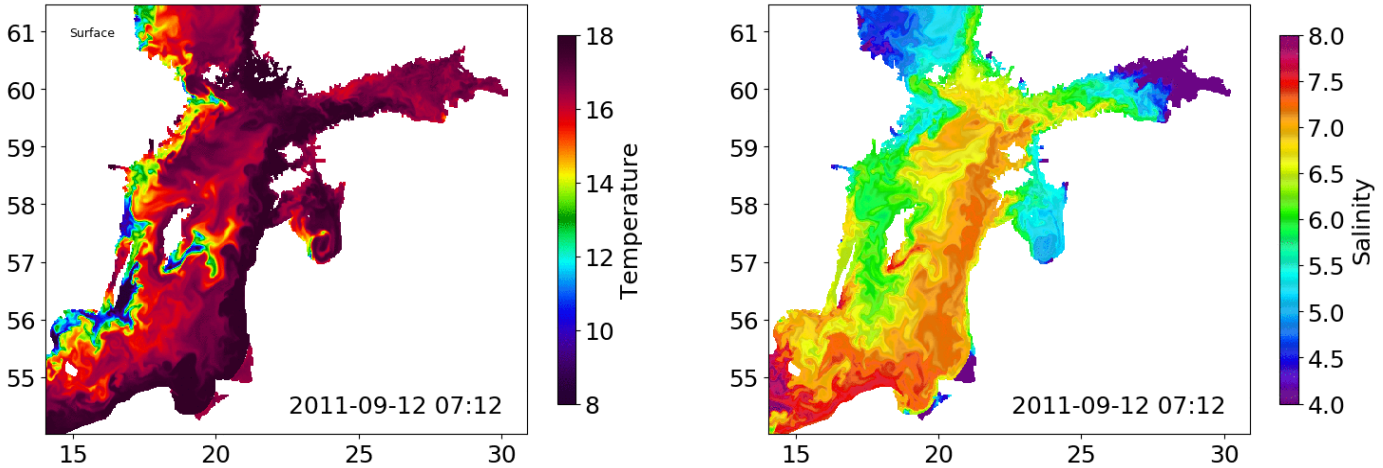


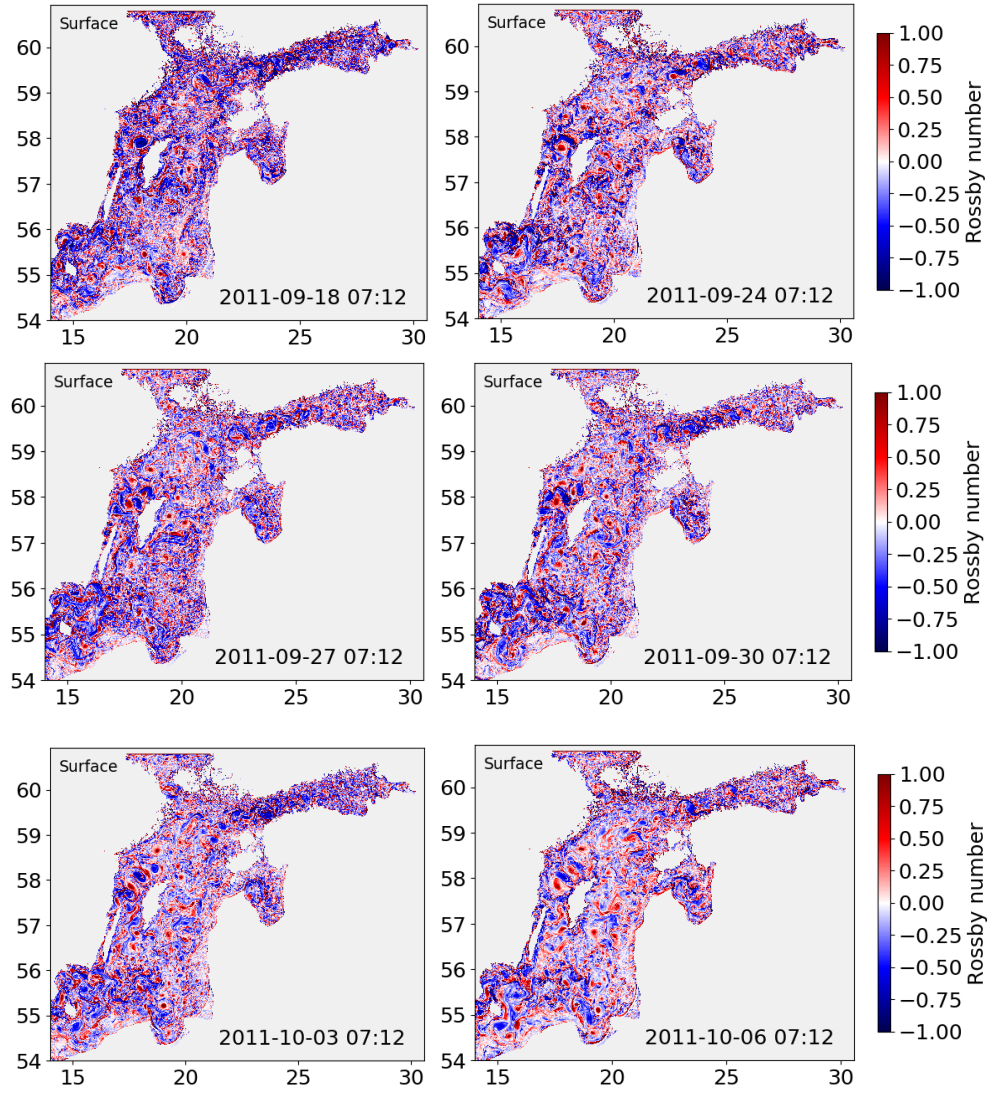
Results: example of mesoscale processes

250m model

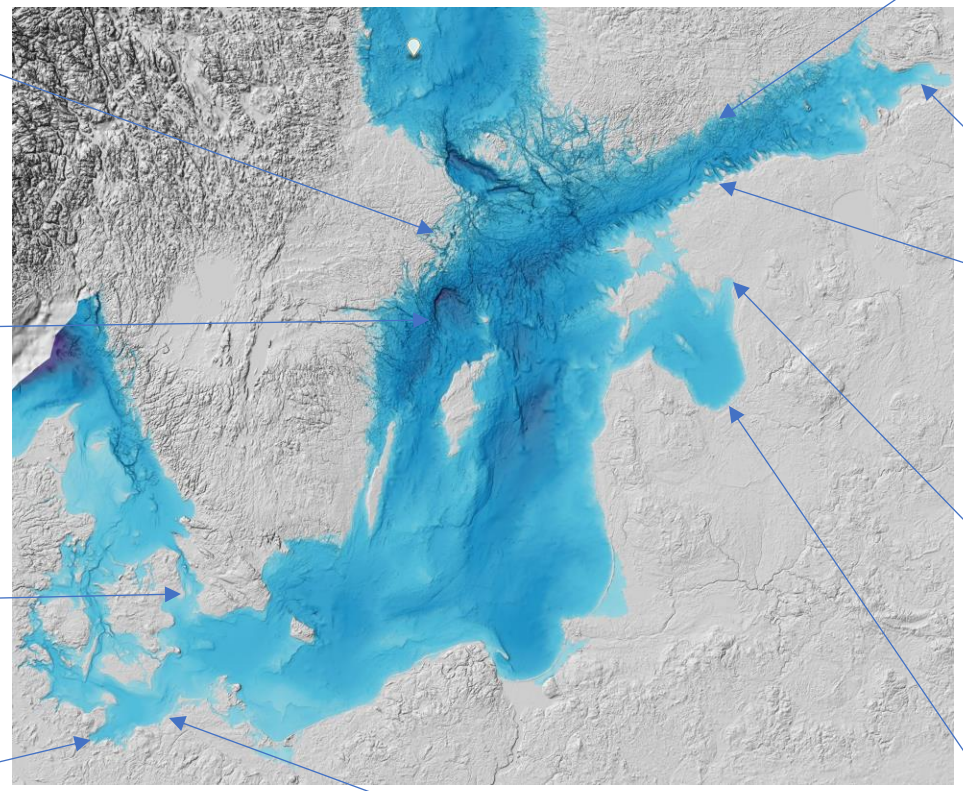


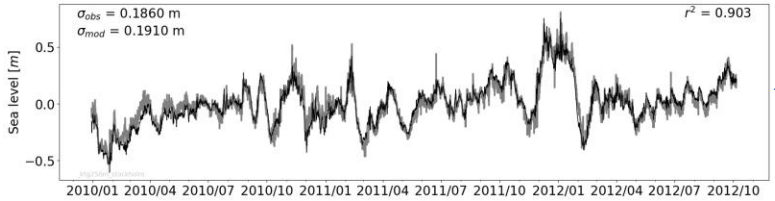
1nm model

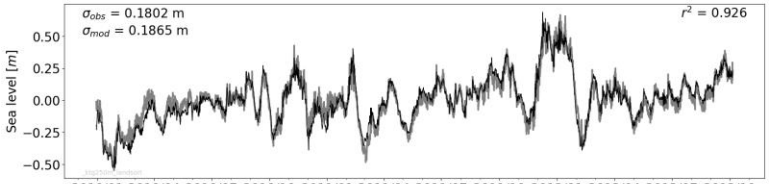


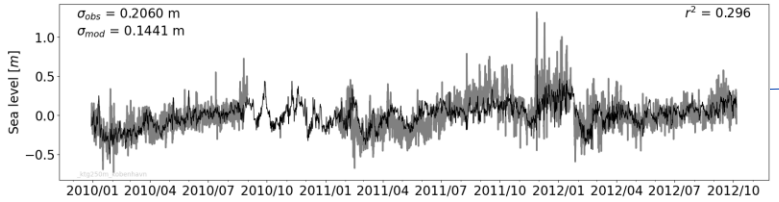


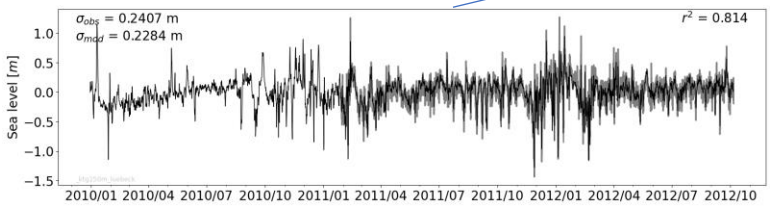
Validation: coastal stations

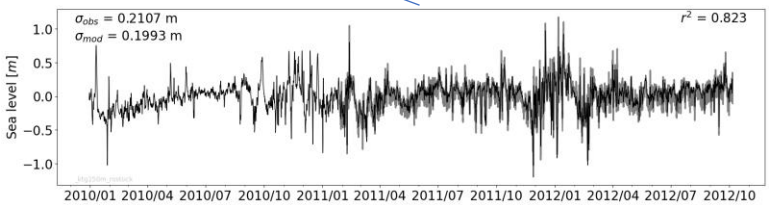


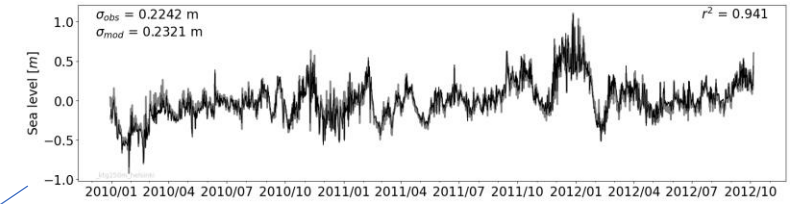


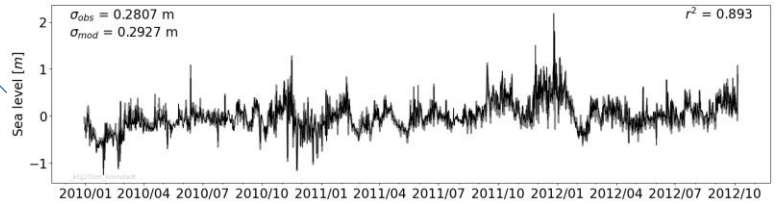


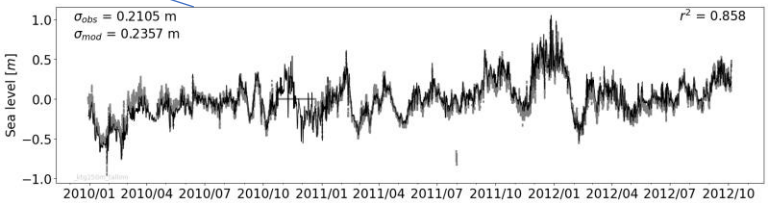


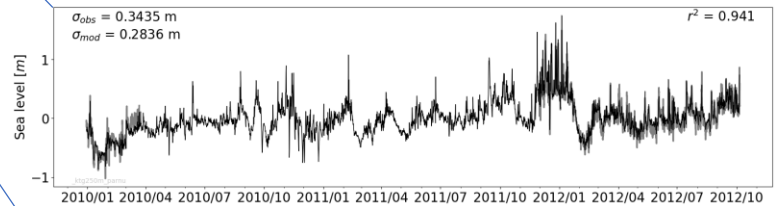


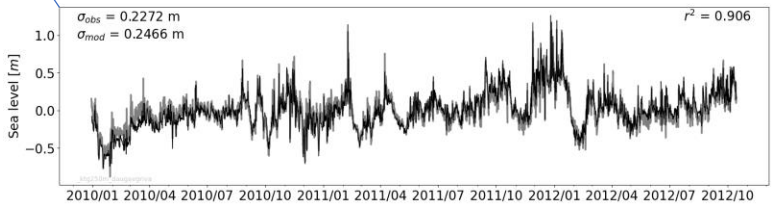




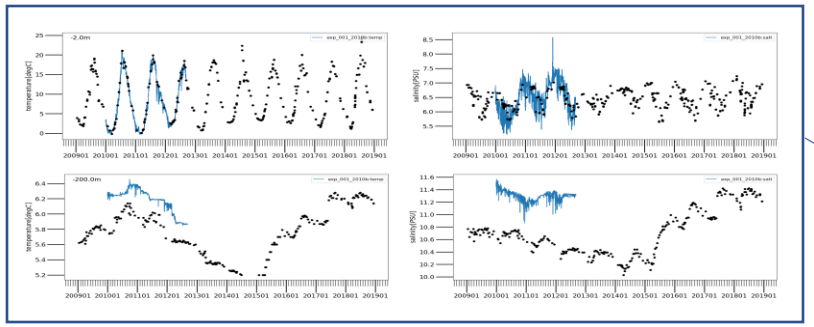


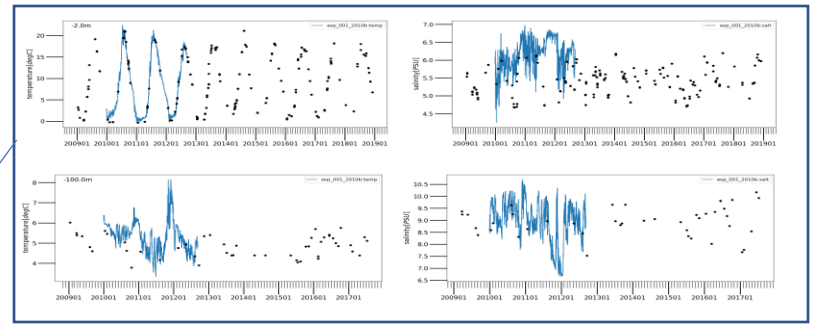


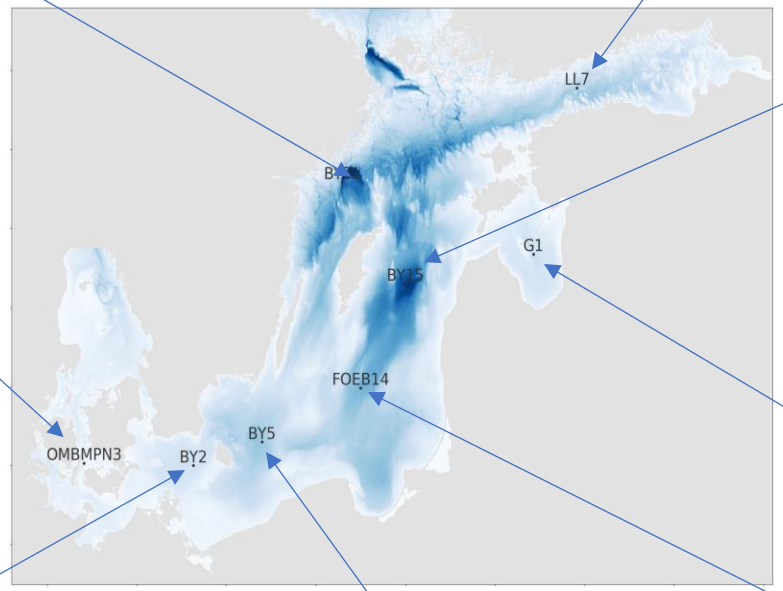


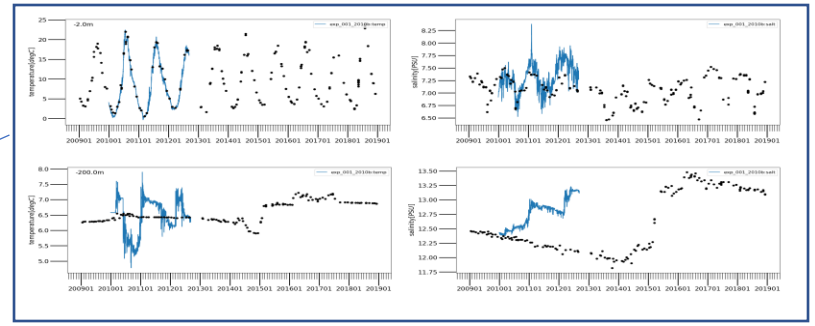


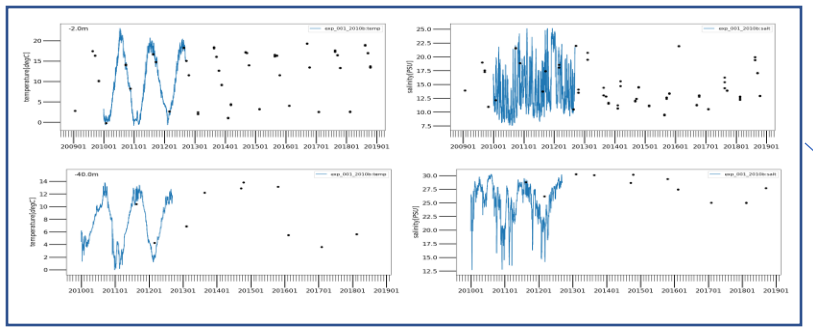
Validation: offshore stations

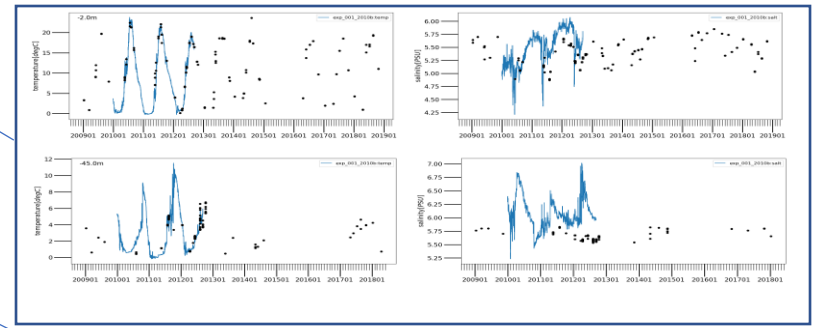


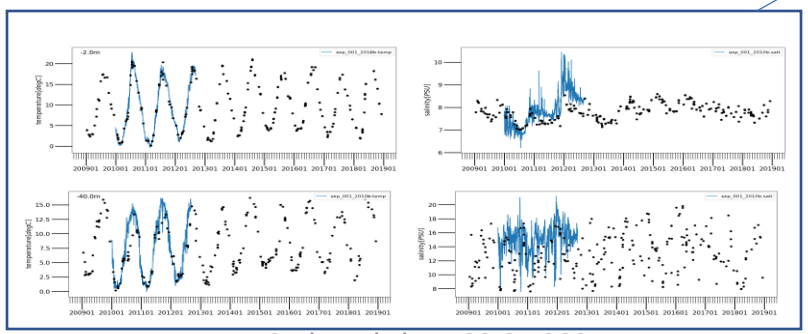


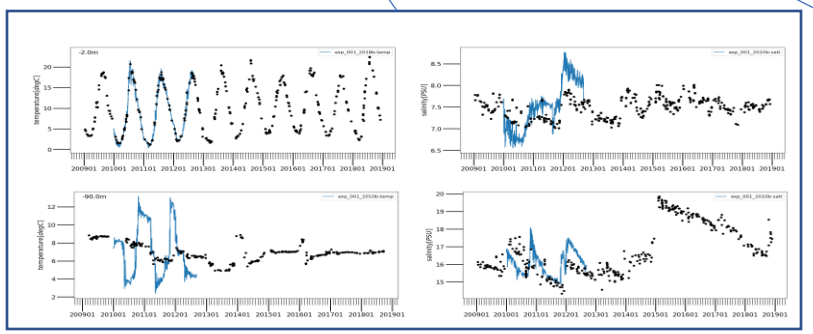


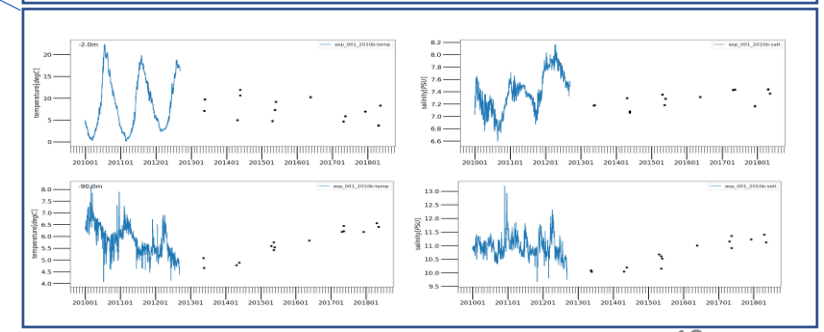












Issues

- Is the price too high?
  - simulation of 1-year at HLRN takes appr. **12** physical days
  - simulation of 1-year at HRLN (18 nodes, medium40) costs appr. **32000** NPLs

- Missing processes/parametrizations?
  - the deep-water salinity/temperature values getting too high
  - surface salinity getting high as well

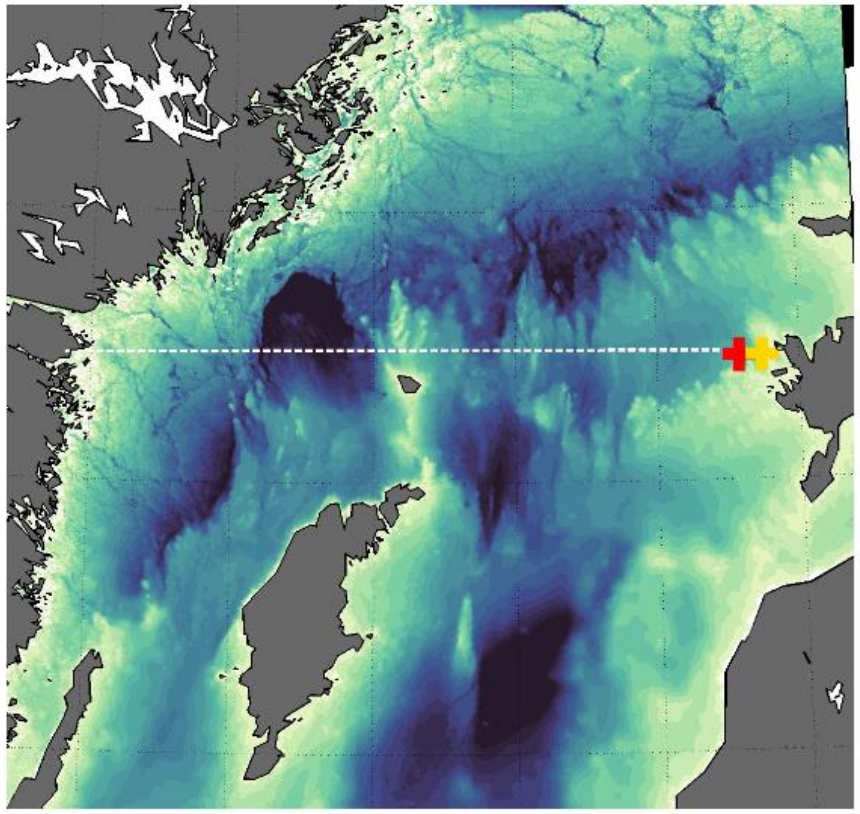
- Are we making wrong assumptions?
  - Non-hydrostatic vs. hydrostatic model

Issues

- How to store the data?
  - re-running model is not "cheaper" than TBs

- How to make post-processing effective?
  - cdo/nco works with large files, but takes time
  - complex algorithms/tools might not work out the box, re-implementation required
  - MPI for post-processing recommended (required)

Off the topic/Advertisment



- Long-term ADCP (appr. 6 months in 2020 at 70m) observations at location marked with red cross
- Possibility to make a validation of slope currents in the models
- Data and info from **Taavi Liblik** (taavi.liblik@taltech.ee)