Leibniz Institute for Baltic Sea Research Warnemünde
IOW

A regional climate system model for the Baltic Sea region

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Introduction

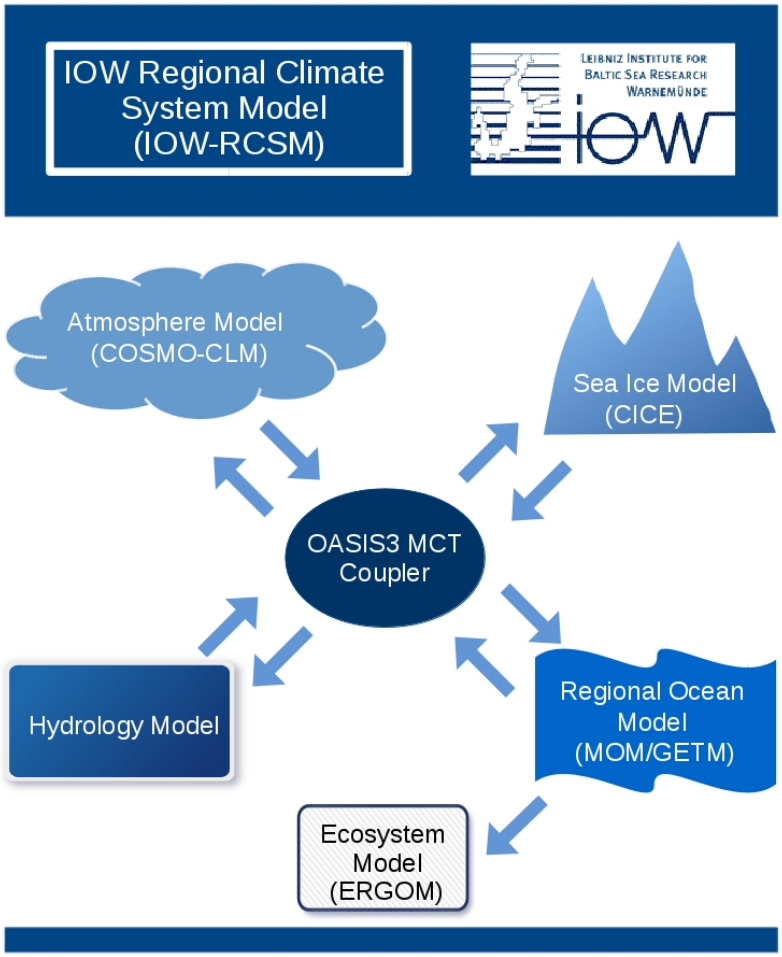
- Baltic Sea accommodates a complex marine ecosystem

- regional climate system models are needed
  - to understand how a changing climate has impacted the marine ecosystem in the past
  - reliable long term observations are limited
  - to predict the consequences of future climate change
  - to resolve local air-sea interactions

- different regional climate model are developed, e. g. *Döscher et al. (2002)*, *Gröger et al. (2015)*, *Ho-Hagemann et al. (2013)*, *Schrum (2017)*, *Wang et al. (2015)*, *Will et al. (2017)*, and others

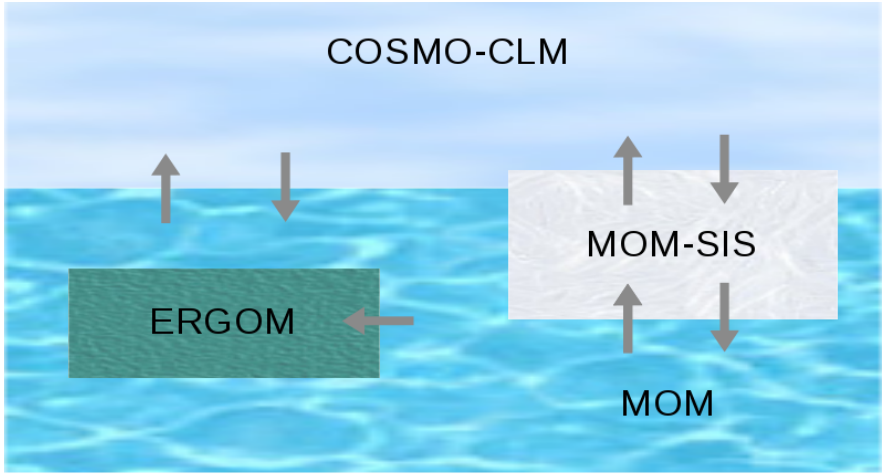
IOW Regional Climate System Model

- IOW-Regional Climate System Model (IOW-RCSM)
- components: atmosphere, ocean, sea-ice, hydrology, bio-geochemistry
- coupler OASIS3-MCT
- switch between different ocean models (MOM and GETM)
- for model development, simulations and validation the computer facilities of the North-German Supercomputing Alliance (HLRN) is used



Current coupling work

- model components
  - Atmosphere: COSMO-CLM *(Rockel et al., 2008)*
  - Ocean: MOM-5 *(Griffies, 2012)*



- communication between atmosphere and ocean (2 executables) through sea-ice model but within 1 MPI environment
- coupler: OASIS3-MCT *(Valcke et al., 2015)*
- incorporation of a sea-ice and bio-geochemical model via an internal coupler in MOM-5 (1 executable)

MOM-5

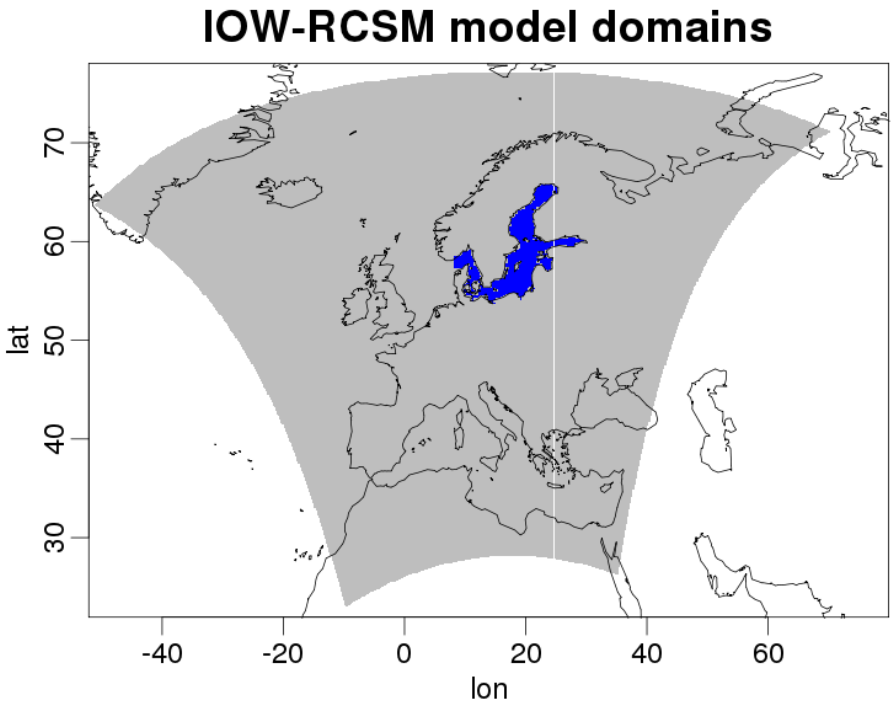
- as ocean component for IOW-RCSM: MOM-5 *(Griffies, 2012)*
- thermodynamic/dynamic sea-ice model SIS *(Winton, 2000)*
- bio-geochemical model ERGOM *(Neumann (2009); Neumann et al. (2017))*
- river runoff: HELCOM assessments *(www.helcom.fi)*

- resolution: 8nm (~14.8km)
- 100 vertical z*-levels
- domain: Baltic Sea (including Skagerrak)
- time step: 1200s

COSMO-CLM

- atmospheric component for IOW-RCSM: COSMO-CLM 5.0 *(Rockel et al., 2008)*
- resolution: 0.22°(~25km),
- domain: EURO-CORDEX
- sponge zone of 10 grid points at the lateral boundaries

- 40 vertical levels
- time step: 150s
- initial setup forced by ERA-Interim reanalysis *(Dee et al., 2011)* data at lateral boundaries



Ecological Regional Ocean Model (ERGOM)

- ERGOM: bio-geochemical model, developed at Leibniz Institute for Baltic Sea Research Warnemünde, by T. Neumann and W. Fennel https://ergom.net
- simulates the bio-geochemical processes in the Baltic Sea, including three phytoplankton groups and a dynamically developing zooplankton variable *(Neumann, 2009)*

- considers the nitrogen and phosphorus cycle *(Radtke et al., 2012)*
- includes oxygen-, sulphur- and carbon cycle elements related to hypoxia *(Neumann et al., 2017)*

OASIS3-MCT

- OASIS3-MCT (Valcke et al., 2015) provides the coupling (two-way online) and interpolation methods

- exchanged mean variables (bi-cubic interpolation):
  - ocean to atmosphere: sea surface temperature and sea-ice area fraction
  - atmosphere to ocean: freshwater and heat fluxes, sea level pressure, wind stress

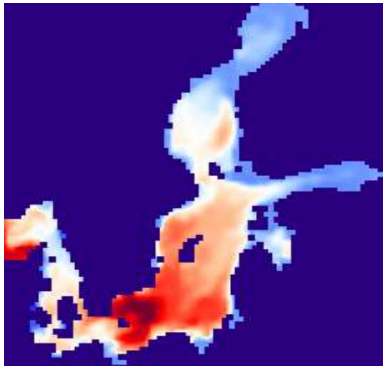
- interface to coupler:
  - OASIS3-MCT interface within COSMO-CLM existing *(Brauch et al., pers.comm.)* and has been adapted for coupling to MOM-5
  - OASIS3-MCT interface within MOM-5 has been implemented

- coupling frequency: 1 hour (LAG: 1 time step)
  (currently performed using bi-linear interpolation)

Status of Coupling work

The coupling from ocean to atmosphere is running (e.g. surface temperature)

OCESESST



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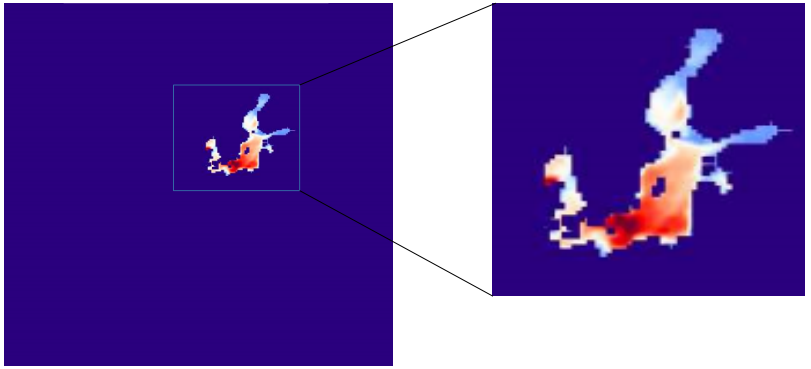
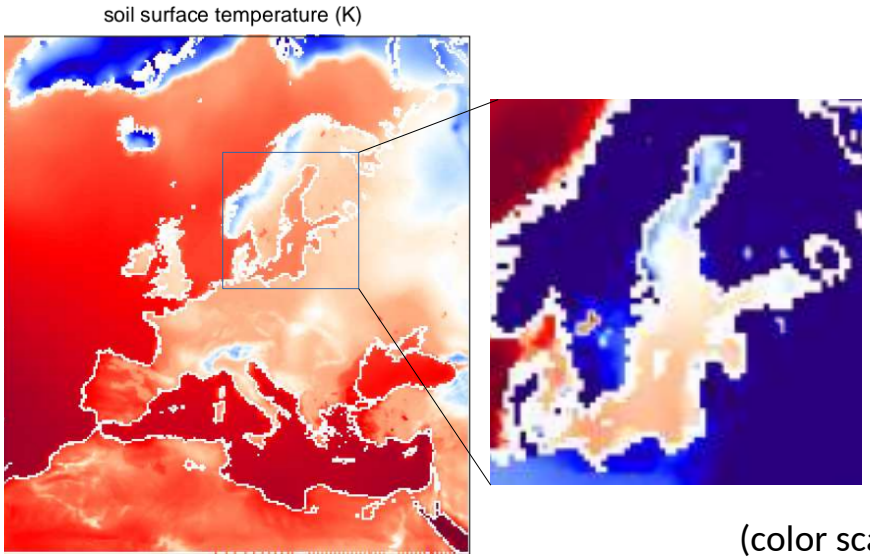
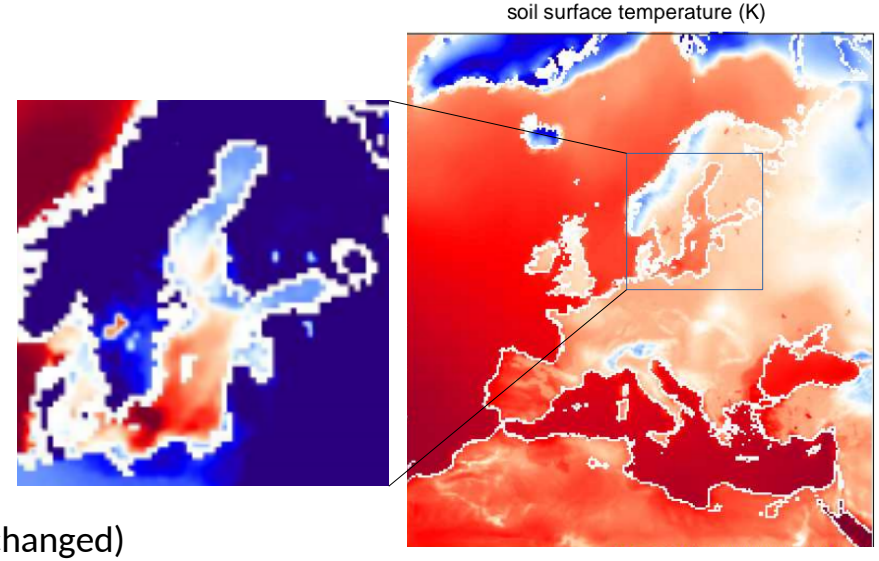


Uncoupled Simulation



Coupled Simulation



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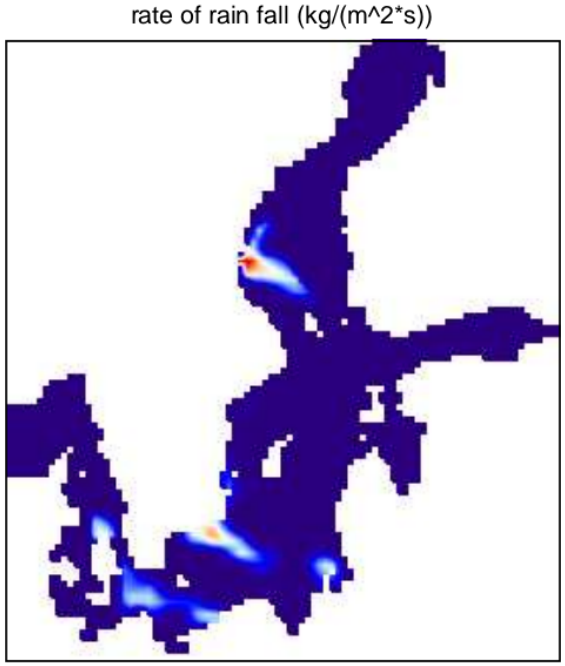
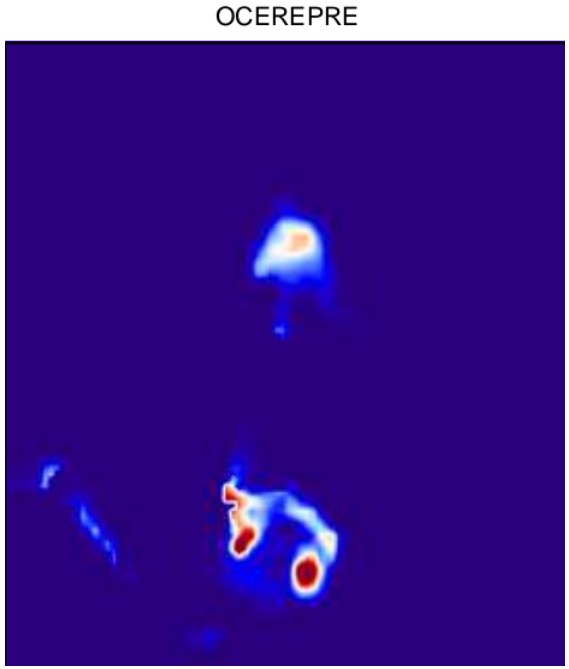
Status of Coupling work

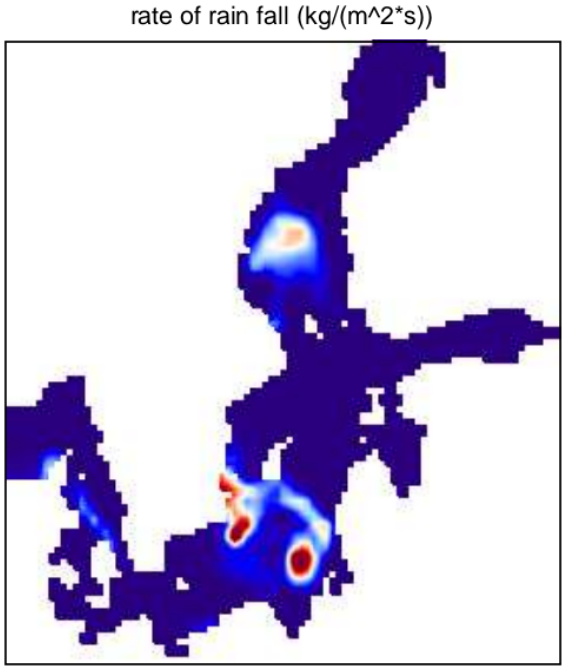
- The coupling from atmosphere to ocean is partially running
  - currently the different forcing parameters are assigned to the corresponding variables in MOM
  - rain, snow, sensible heat flux and long wave radiation are done
  - wind stress, sea level pressure, latent heat flux, short wave radiation are work in progress

Uncoupled Simulation





Coupled Simulation



Summary

- The first version of IOW-RCSM consists of COSMO-CLM as atmospheric component and MOM-5 as ocean component, which includes a sea-ice (SIS) and the bio-geochemical model (ERGOM)

- current status of the development:
  - OASIS3-MCT interface within COSMO-CLM has been adapted for coupling to MOM-5
  - OASIS3-MCT interface within MOM-5 has been implemented
  - currently the remaining coupling fields are assigned within MOM-5

Outlook

- validation of the IOW-RCSM results using observations and other models
- long-term paleo-simulations to study e. g. the variability of Major Baltic Inflows and its relation to large-scale atmospheric circulation
- contribute to the coordinated experiments in the Baltic Earth framework