How much carbon can the coastal ocean store?

Carbon Storage in German Coastal Seas - Stability, Vulnerability and Perspectives for Manageability

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In Short

- Biogeochemical modelling of carbon pools in the coastal ocean
- Quantification of changes in carbon pools
- Identify potential changes in carbon pools due to climate change

Our project, "Carbon Storage in German Coastal Seas – stability, vulnerability and perspectives for manageability" investigates the stability and vulnerability of various carbon storage pools in the German marginal seas, North Sea and Baltic Sea. Germany and its European neighbours have a long history of exploiting, over-exploiting and rehabilitating their coastal waters. This is a consequence of human pressures on these coastal systems, paralleled by climate change driven pressures. Both have the potential to alter the biogeochemistry of the marine ecosystems. We will determine whether and to what extent relevant pathways for carbon storage have been impacted or will be impacted.

Motivation The overall goal of this project is to establish a budget of organic matter, nutrients, total alkalinity and dissolved inorganic carbon for the North Sea - Baltic Sea - Wadden Sea continuum. The sensitivity of these pools to climate change and anthropogenic activities will be investigated as well as the stability of different pathways for carbon storage in the North-Baltic-Wadden Seas. These goals will be realised using a coupled physical - biogeochemical model for the North-Baltic-Wadden Sea continuum Fig. 1.

The Modelling Although the North Sea and the Baltic Sea are a coupled system, this has been only poorly reflected in the modelling efforts until relatively recently. The differences in the two systems are also reflected in the approaches taken to model these. During the last 10 years, some efforts were undertaken to bridge both systems using higher spatial resolution or vertical adaptive coordinates (e.g. Gräwe et al.,2015a; Hordoir et al., 2019). The need for a further developed coupled model system including a sophisticated biogeochemical module is also motivated by the results by Pätsch et al. (2017); Placke et al. (2018) and Daewel et al. (2019), who clearly reveal shortcomings in our present capabilities to simulate these systems as one entity appropriately.

In this project, we are developing a coupled hydrodynamic - biogeochemical model for the North-Baltic-Wadden Sea continuum using the General Estuarine Transport Model (GETM, Klingbeil and Burchard (2013); Gräwe et al. (2015)) ocean model coupled with the Ecological Regional Ocean Model (ERGOM) (Neumann, 2010; Radtke et al., 2019). In Fig. 1, we show the bathymetry and model domains, used in this study. Although ERGOM is used and developed since several years at IOW (Radtke et al., 2012; Neumann et al., 2017), no attempt has been made to extend it to the North Sea. Thus, the silicate-cycle has to be included. Moreover, since the Carbostore project deals with the carbon-cycle, we need to improve its representation in the current ver-

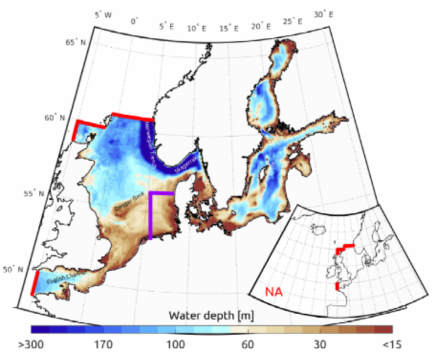

__Figure 1:__ Water depth of the North Sea / Baltic Sea. The red lines delineate the boundary of the 2nm North Sea-Baltic Sea setup at the Northwest Shelf. The purple lines delineate the boundary of the Southern North Sea 600m setup.

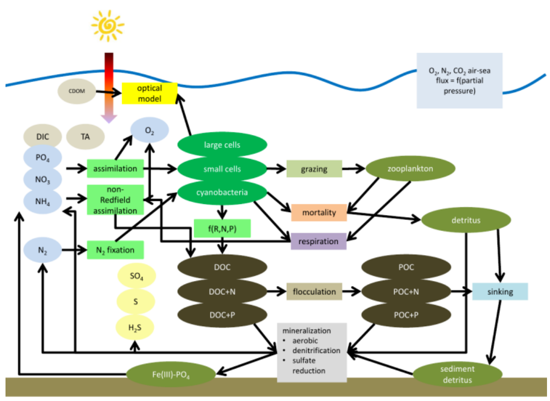

__Figure 2:__ Extended Carbon Ecological Regional Ocean Model (ERGOM, Neumann et al., 2020, Neumann et al., submitted)).

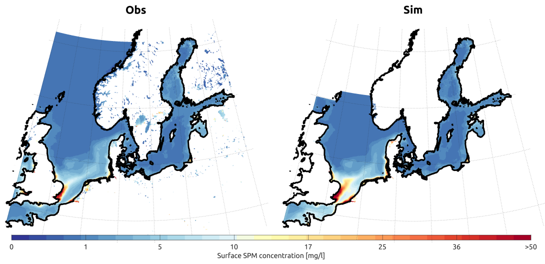

Figure 3: *Observed versus simulated SPM for North Sea - Baltic Sea 2nm setup (Observations courtesy of Copernicus GlobColour Project, 2010 - 2018).*

sion of ERGOM (herein referred to as ERGOM2020) which contains 27 state variables. Some progress has already been made in this context (Neumann et al., submitted 2022), but further work is planned, such as improving the alkalinity-modifying processes in the sediment and pelagic, modifying the DOM-alkalinity dynamic, adding ^{13}C to the carbonate cycle and implementing calcareous shell formers and dissolution of calcareous shells. There are already some studies that are guiding us in the application of ERGOM in the North Sea (Maar et al., 2011; Wan et al., 2012). Furthermore, due to existing collaborations with the BSH, we have access to their 'experimental' ERGOM version for the North Sea. We plan to implement ERGOM with 30 state variables in order to better represent the biogeochemistry of the North Sea and Baltic Sea.

An essential process in the North Sea is the representation of light shading due to suspended particulate matter (SPM), which can, especially in the German Bight, reduce the Secchi depth to several 10s of centimetres. To have a robust estimation of the SPM field, we have implemented an adaptation of the 'first-order' model of Van Kessel et al. (2011). This accounts for the direct suspended load and the buffering of fine sediments in the sandy bottom pool (Fig. 2).

WWW

http://www.io-warnemuende.de

More Information

[1] Carbostore Project https://www.carbostore.de/

[2] https://getm.eu

[3] https://ergom.net

Project Partners

University of Oldenburg, University of Hamburg

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