# Modeling longterm changes of the Baltic Sea due to eutrophication and climate change

**Provision of model results and scenario simulations for a blue sustainable eutrophication management of the Baltic Sea (CodeBlue)**

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## In Short

- The longterm development of the water quality in the Baltic Sea will get simulated with IOW´s coupled hydrodynamic biogeochemical model system MOM-ERGOM
- Focus will be three hindcast simulations covering the time span 1950-2024
- The model simulations will help to distinguish the eutrophication impacts (due to a very high amount of anthropogenic nutrient inputs into the Baltic Sea) from climate change driven impacts
- Therefore, three simulations will conducted with either realistic nutrient inputs or weather conditions, or forcings without eutrophication or climate change signals

Like many other seas, the Baltic Sea or the North Sea (and their ecosystems) are under severe pressure from eutrophication and climate change. To counteract these pressures, the countries around the Baltic Sea have decided to set upper limits for nutrient inputs into coastal waters to restore good environmental status. While the determination and implementation of these upper limits are a major step towards the good ecological status (or at least an improved one), they were developed without including climate change properly.

To bridge this gap, several research institutes work within the EU-project CodeBlue together to provide a sophisticated model ensemble, which will cover first the past 75 years, and in a second step also the entire 21st century. The key questions are how climate change and eutrophication interact as well in the past period as in the future, for which reliable nutrient input ceilings and reduction measures are needed. From past model studies (e. g. Friedland et al. 2021, 1), it is known that running coordinated ensemble studies instead of performing single model runs is a step stone forward to derive consistent and robust model results, as they are requested by stakeholders and end-users.

Therefore, computing time is requested to run IOW´s coupled hydrodynamic-biogeochemical model MOM-ERGOM (covering the entire Baltic Sea with a horizontal resolution of 1 nautical mile) for the hindcast period (1950-2024) with different nutrient inputs and weather forcings to separate the impacts from the too high nutrient inputs and the already happened climate change.

If the hindcast runs are successfully conducted, we will apply in a second step later for additional compute resources to perform also the scenario simulations covering the entire 21st century assuming at least two climate change and nutrient input scenarios.

The model simulations will continue previous studies on the longterm water quality changes (e. g. Friedland et al. 2025, 2), but will be updated due to newly available nutrient input data by van Leeuwen et al. (2024, 3, see Fig. 1). They will allow to model the realistic development from the low nutrient input phase around 1950 to the input peak in the 1980ties and further until nowadays, where nutrient inputs have declined again. To study the impact on the water quality (expressed via the dissolved inorganic nutrient, algae blooms, seechi depth or near-bottom oxygen concentrations) of the strong nutrient input increase, a second hindcast simulation will get conducted, where the nutrient inputs stay on the level of the 1950ties.

On the other hand, the marine water quality is strongly affected by weather conditions and especially the ongoing warming due to climate change. To tackle this impact, another hindcast simulation will be conducted, where the realistic nutrient inputs are used, but the weather forcing will be detrended, in order to take out the climate change, which has already happened over the past decades.

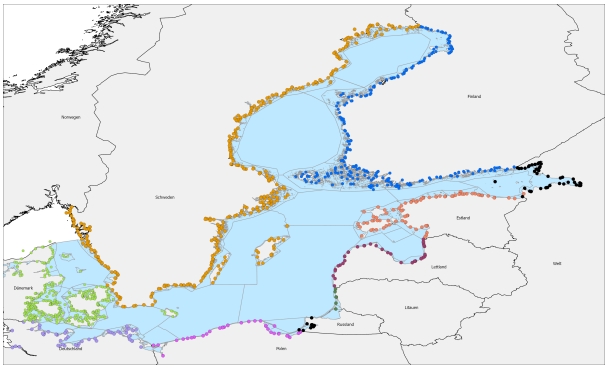

***Figure 1:** Nutrient and freshwater inputs for the NHR project will be provided in accordance to the EMORID database 3*

## WWW

https://www.io-warnemuende.de/projekt/373/codeblue.html

## More Information


[1] R. Friedland, et al., *Frontiers in Marine Science*, **8**, (2021). doi:10.3389/fmars.2021.596126

[2] R. Friedland, et al., *Frontiers in Marine Science*, **12**, (2025). doi:10.3389/fmars.2025.1617660

[3] S. van Leeuwen, *EMORID riverine database*, (2024). doi:10.25850/nioz/7b.b.th0


## Project Partners

Swedish Meteorological and Hydrological Institute (SMHI), many more

## Funding


EU Sustainable Blue Economy Partnership (SBEP)


## DFG Subject Area

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