Capabilities of Operational Ecology in the Baltic Sea

Understanding Operational Ecology

Supporting environmental assessment and ecosystem-based management, Operational Ecology (OE) reconstructs past history and aims to predict the future status of the marine environment and ecosystem. It is application-focused, delivering regular quality ensured information products in support of management and decision making via information that is relevant and in a format which can be easily accessed. R&D efforts include but are not limited to optimization of monitoring network and models, data assimilation, \textit{in situ} observations and fisheries data.

The Baltic Sea regional model system

The circulation model implemented in this project is HBM (HIROMB-BOOS ocean circulation model) and the biogeochemical model is ERGOM. They were selected as the operational models by the members of the Baltic Framework of MyOcean project. HBM has a well-documented development history and features a two-way nesting technique.

The main higher trophic level model used was the SMS model, a stochastic multispecies model describing stock dynamics of interacting stocks linked together by predation. It operates on annual or seasonal time steps.

Regional Challenges

Due to a less-dynamic water cycle, warming climate and increased anthropogenic impacts, the Baltic Sea region has been experiencing problems of hypoxia, harmful algal blooms, eutrophication and regime shift of fishery species in the past decades. In order to make the correct management decisions for reaching a Good Environmental Status and healthy ecosystem, timely and accurate information on the physical, biogeochemical and ecosystem state are essential.

Currently the biogeochemical monitoring network in the Baltic Sea is undersampled and therefore cannot provide sufficient information for a rapidly updated environmental assessment update. The assessment of subsurface chl-a and nutrient monitoring networks show that the variables are effectively covered by only around 40-70%. Hence the key challenge is to understand, assess and predict the status of the marine environment and ecosystem at relevant scales (seasonal, inter-annual and decadal) efficiently and accurately by combining models and observations.

From a systems perspective identifying which components of the ecosystem are manageable and which components must simply be adapted to, is a key part of sustainable fisheries management and may be achieved by including anticipated climate change in determining biological reference points. In unstable environments the adaptation of management to changing conditions is a crucial aspect of sustainable exploitation of marine resources.
What can the Baltic Sea model system tell us?

In the Baltic Sea, modelling is regarded as part of monitoring. Models represent the relationship between the forcing and biogeochemical processes and internal ecosystem dynamics. The latter may not be perfect but major processes in the trophic levels are included. Through data assimilation, the model-based dynamics and correlation patterns can be used for spreading the observations in space and time. This has proved far more efficient and robust than purely statistical interpolation. The model quality is the central issue of this methodology.

For the Baltic Sea, models are capable of simulating variability of lower trophic level and biogeochemical variables at the surface. For the subsurface and bottom variables, through data assimilation, models can generate reasonable and useful products but it is clear there is room for improvement. Higher trophic level models improve their predictive skill by including environmental forcing, where appropriate.

The performed operational simulations in the Baltic Sea include operational forecast over a few days, Rapid Environment Assessment in a delayed mode of a few months or one year, and hindcast and reanalysis for the past 20 years as seen in figure 1 (data products for operational forecasts are publically available and free to download from http://portal.marineopec.eu).

A dedicated program has also been developed to derive a list of ecological indicators from these products.

Taking OE forward in the Baltic

• Specific observing system experiments should be designed and implemented for optimizing the existing monitoring networks and end-to-end model systems, so that both the model and the monitoring are matched to generate a benefit for the forecasts, REA and reanalysis through data assimilation.

• Existing biogeochemical assimilation schemes should be further developed, calibrated and operationalized.

• For higher trophic levels spatial resolution would be improved and consolidated through improved monitoring programmes

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