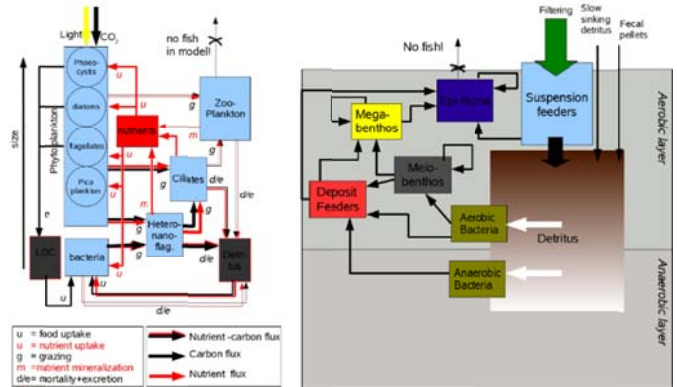


## GETM-ERSEM-BFM

**Model type:** Three-dimensional, time resolving coupled hydrodynamics and biogeochemistry model. Components include tidal and wind-driven currents, temperature, salinity, nutrients, suspended particulate matter, under-water light, phyto- and zooplankton, bacteria, mesozobenthos and detritus. Parameterisations and parameter settings are based on a wide range of sources, including literature, field surveys, and laboratory observations. Time- and spatially varying model forcing consists of tidal elevations, temperature, salinity and nutrient concentrations derived from a combination of observations and boundary conditions sourced from other models that cover a larger spatial domain. Inputs include winds, air temperature, humidity and cloud cover from global atmospheric models for surface forcing, and riverine runoff and nutrient concentrations from observations for riverine inputs. The GETM hydrodynamics model is used in several European countries (since 1990s) and models for any region can be developed given appropriate resources. The ERSEM-BFM biogeochemical model is tailored to temperate shelf seas and is used at NIOZ in the Netherlands and at Cefas.



### Existing Models for UK shelf seas:

Area Modelled	Includes		Spatial Scale		Quality (data used)
	Hydro	BGC	Domain	Res. (km)	
North Sea coarse	x	x	48-60N, 4.5W-16E	11	1-14, Work-horse and development model
North Sea fine	x		48-60N, 4.5W-16E	3.5	1, 2, 5, 6, 11, 13, 14, Not in active use.
Irish and Celtic Seas	x		48.8-56.8N, 9.6-2.5W	3.5	1, 2, 5, 6, 9, 11, 14, Mainly for particle tracking.
English Channel	x		48-51.35N, 6.5W-2.4E	1	1, 2, 5, 6, 11, 13, 14, For local particle tracking.
Cross-shelf	x		46.4-64N, 20W-13E	3.5	1, 2, 5, 11, 13, 14, Used for boundary conditions.
NW European. shelf	x	x	46.4-63N, 17.5W-13E	5	1, 2, 4, 5, 6, 8, 9, 11, 12, 13, 14, In development.

1. NOOS bathymetry, 2. Topex-Poseidon satellite altimetry, 3. North Sea Project cruises, 4. SmartBuoy, 5. Tide gauges, 6. Current meters, 7. RIKZ marine monitoring programme, 8. Ferrybox, 9. ICES temperature and salinity, 10. OSPAR 2002 combined data, 11. National River Flow Archive, 12. EA riverine nutrients data, 13. European river data, 14. ECMWF reanalysis meteorology.

### Existing uses:

- Evaluating impacts of structures (e.g. tidal turbines, windfarms) on hydrodynamics.
- Evaluating management scenarios for anthropogenic riverine nutrients discharge and impacts on eutrophication.
- Evaluating extent of transport of nutrients and impacts of eutrophication across national boundaries.
- Evaluating potential impacts of large-scale marine renewable energy extraction (wind farms, macro-algae farms, tidal farms) on hydrodynamics, biogeochemistry and primary production.
- Evaluating dispersal of particles (eg. eggs and larvae, non-native species, litter), and connectivity between areas.
- Provision of food fields for other ecosystem model and spatial fields to supplement observations-based studies.

### Potential new uses:

- Designing and optimising monitoring programmes.
- Assessing anthropogenic and climate impacts on hydrography, biogeochemistry and primary production.
- Evaluating spatial management including the impact of new structures and macro-algae farm location
- Quantifying the performance and trade-offs between different management strategies to achieve MSFD.
- Evaluating the connectivity between networks of structures and protected areas.

### Key modelling issues:

- Setting inputs (parameterisation) and testing outputs against real data (calibration) is an essential, but resource-intensive and on-going process to ensure quality and improve predictions.
- Obtaining optimal boundary and forcing conditions for the time periods of interest.
- Understanding the impact of changing inputs on the outputs from the models (sensitivity) and the effect of uncertainty in model parameters on robustness of model predictions.
- High performance parallel computing facility required.

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