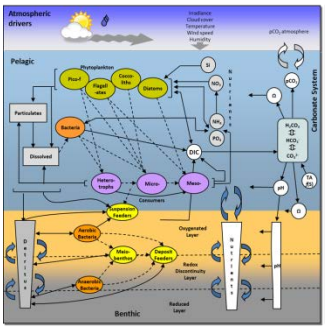
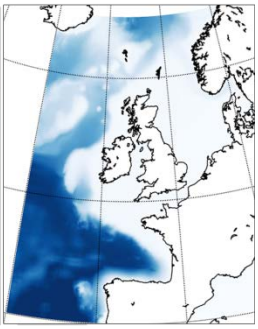
NERC Modelling National Capability for the NW European Continental Shelf

NERC National Capability in shelf sea modelling is delivered by the National Oceanography Centre (NOC) and the Plymouth Marine Laboratory (PML) in a sustained and coordinated programme of model development, evaluation, application and analysis. This has also been supported by NERC Theme Action Programmes on Shelf Seas Biogeochemistry, Marine Ecosystem Research, and Ocean-Shelf Exchange (FASTNet). Together these have provided, and continue to provide, substantial advances in our shelf sea modelling capability that are available for this programme. NERC National Capability is currently being re-commissioned and, while some relevant elements have been recently commissioned, there remains some uncertainty. For the shelf scale modelling of hydrodynamics and ecosystem on seasonal to decadal time scales, the National Capability centres around the NEMO and ERSEM models respectively.



European Regional Seas Ecosystem Model ERSEM



NEMO AMM7 Domain

NEMO provides the global, regional ocean-basin scale and shelf scale hydrodynamic modelling capability at the NOC and the UK Met Office, as well as being the model of choice for European Operational Oceanography. It is developed and supported by a consortium of six institutions in UK, France and Italy, and used in several hundred projects worldwide. Its code base is professionally managed, tested and quality controlled by the NEMO systems team, who also provide user support via a mail list and an annual meeting. The code is freely available under the open source CeCILL license for download on registration at the NEMO website (http://www.nemo-ocean.eu/).

The NEMO model data available for this programme under NERC NC comes from configurations developed by the Joint Coastal Ocean Modelling Programme (JCOMP), a JWCRP programme between the Met Office and NOC. This particularly targets the delivery of the hydrodynamic forecast and reanalysis components of the NW European Shelf contribution to the Copernicus Marine Environmental Monitoring Service (CMEMS). The latest configuration is the 7km Atlantic Margin Model (CO6, based on NEMO V3.6_stable, going operational in 2016). This is a ~7km resolution latitude, longitude grid with 50 terrain following levels in the vertical, covering the NE Atlantic from Spain to Iceland to Norway. It integrates forward in time temperature, salinity, velocity, sea surface height, turbulent kinetic energy and dissipation. For CMEMS this is run (by the Met Office) in both reananlysis (~last 35 years) and 5 day forecast mode. Output frequency is typically daily for 3D fields and hourly for selected surface and sea bed fields. Data from these simulations is freely available from the CMEMS website (as netcdf files; http://marine.copernicus.eu/), alongside Quality Information Documents, describing the extensive validation of the model products. The CMEMS system includes data assimilation, using the NEMOvar approach. Currently this is limited to sea surface temperature, but profile and altimetry assimilation is underdevelopment. The development and running of assimilative NEMO models has been done at the Met Office, as it is not an area NOC is generally involved in.

The next evolution of this system is the 1.5km (AMM15) model currently under development. This covers a slightly reduced area, but substantially better meso-scale process

representation (e.g. of front, river plumes and internal tides). This configuration is also supported by the recently funded LOCATE NC project, and decadal hindcast simulation data will be available from the start of this programme accepting that this will be 'early access', and will not be subject to same quality control and easy data delivery as the operational product (available c2018). While there will be some scope for this programme to inform the evolution of the NWS Copernicus service, this will be limited by resource and operational constraints, so new simulations, bespoke model output, diagnostics and analyses, should form part of the costed programme.

ERSEM is a generic lower trophic level ecosystem model. It originated from European projects in the 1990's in the context of the North Sea and has been developed at PML since then. It simulates the cycling of C, N, P, Si and O_2 through (typically) four phytoplankton and three zooplankton functional groups, bacteria, several detrital classes, inorganic carbon chemistry and a full benthic model. It is coupled directly to a range of hydrodynamic models that treats the transport of these components (at full time/space) resolution and provide physical parameters for the ecosystem model; in the context of this programme this will be the NEMO shelf-sea configurations described above. It has recently been substantially redeveloped in the NERC/Defra Shelf Seas Biogeochemistry and Marine Ecosystem Research Programmes. Notably it has been incorporated within the Framework for Aquatic Biogeochemical Modelling (FABM). FABM enables the rapid, run-time combination of any number of sub-models into a coupled ecosystem model. It enables the software to scale from a classic ERSEM configuration up to multiple functional type setups or down to an NPZD configuration using a single, unified code base. This modular model has been adopted for all future developments within both the Marine Ecosystems Research Program (MERP)[1] and the Shelf Sea Biogeochemistry (SSB) program thus facilitating seamless traceability between the configurations used in both programs. Other developments include improving the nitrogen cycling and restructuring the benthic model. Its dissolved organic matter component will be substantially developed in the LOCATE project.

ERSEM code is freely available on registration at http://shelfseasmodelling.org/. It also forms part of the NW European Shelf Operational Copernicus system, being run in the AMM7 and, planned in the AMM15 configurations described above. Basic ecosystem and biogeochemical variables (e.g. chlorophyll, nutrients, and oxygen) are freely available from both the forecast and reanalysis products described above at the same time frequency. In addition quantitative metrics to evaluate simulation skill in matching in situ biogeochemical data are available as an open source tool for model validation (https://github.com/bcdev/opec-tools).

Funded thought the National Centre for Earth Observation (NCEO), PML is using an Ensemble Kalman filter to assimilate satellite Ocean Colour into ERSEM. Recently the first reanalysis simulation of the NW European shelf was completed, assimilating satellite ocean colour into ERSEM for the period 1998-2012. The reanalysis product is available for download and applications at the data portal http://portal.marineopec.eu/

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[1] http://www.marine-ecosystems.org.uk/