WP4: Integrative Modelling for Shelf Seas Biogeochemistry

Shelf seas are of major societal importance providing a diverse range of goods (e.g. fisheries, renewable energy, transport) and services (e.g. carbon and nutrient cycling and biodiversity). At the same time they are under enormous pressures from man's activities which may have significant impact on the basic function of such systems. For example climate change will lead to large scale changes in stratification and temperature, while increasing atmospheric CO_2 levels will lead to acidification of the oceans with significant impacts on ocean biogeochemistry. Simultaneously combinations of direct human activities (e.g. fishing, and eutrophication) directly impact the biogeochemical cycles of carbon and nutrients.
Our understanding of the biogeochemistry of the shelf seas is limited and many processes are poorly understood, in particular the biogeochemical budgets of carbon and nutrients. The key questions include is the UK continental shelf a source or sink for carbon and nitrogen remain unanswered. In addition there are gaps in our knowledge of some of the key physical, chemical and biological controls on biogeochemical cycles. By synthesising empirical knowledge into quantitative descriptions, computer models allow scientists to investigate the functioning of, and interactions between, ecology, biogeochemistry, anthropogenic pressures and climate.

The overarching scientific goal is to enhance our capacity to assess the controls on biogeochemical cycling and hence to quantify with uncertainties the budgets of carbon, nitrogen, phosphorous and silicon including their response to climate, natural variability and anthropogenic stress. The underpinning strategic goal is to develop a new shelf seas biogeochemical model system, coupled to a state of the art physical model, capable of predicting regional impacts of environmental change from days to decades.

WP4 will build upon the considerable expertise in shelf sea biogeochemical and physical modelling available in the UK to develop a new shelf biogeochemical model system for use by the UK science community. This will be based on the existing ERSEM shelf seas biogeochemistry model. It will ensure that the ocean biogeochemical model developments necessary to achieve our priorities receive support from the broader community, including modellers, biogeochemists and oceanographers. The legacy will be a state of the art model tool to support scientific research, operational oceanography and marine policy (e.g. Marine Strategy Framework Directive, and Marine and Climate Acts).

The program will address a range of key scientific questions, which provide a framework for model development, simulation experiments and analysis. These will also inform the design of the observational and experimental elements of the Shelf Seas biogeochemistry programme.

- How does the interaction between stratification and turbulence on tidal to seasonal scales impact shelf scale biogeochemical budgets, especially on decadal timescales?
- What controls plankton community structure at seasonal and interannual timescales, and how does this structure impact on the composition of detrital material and hence the amount, quality and rate of supply to the benthos.
- At what temporal /spatial scales and in which regions does calcification exert a significant impact on the shelf seas inorganic carbon budget?
- Do microbial loop dynamics impose a control on the recycling of C, N, and P in benthic and pelagic systems?
- What is the influence of zooplankton in controlling the biogeochemical cycling of shelf seas?

- Are shelf scale biogeochemical budgets sensitive to changes in physical processes acting at the benthic pelagic interface?
- Are shelf seas biogeochemical budgets sensitive to changes in benthic community structure and activity?
- Are the UK shelf seas a source or sink for climatically active gases; specifically CO_2 and N_2O?

Finally, in order to aid interpretation of model predictions we will assess what determines and potentially limits the model's capability to predict the various components of the marine ecosystem (including physics, pelagic and benthic processes)?

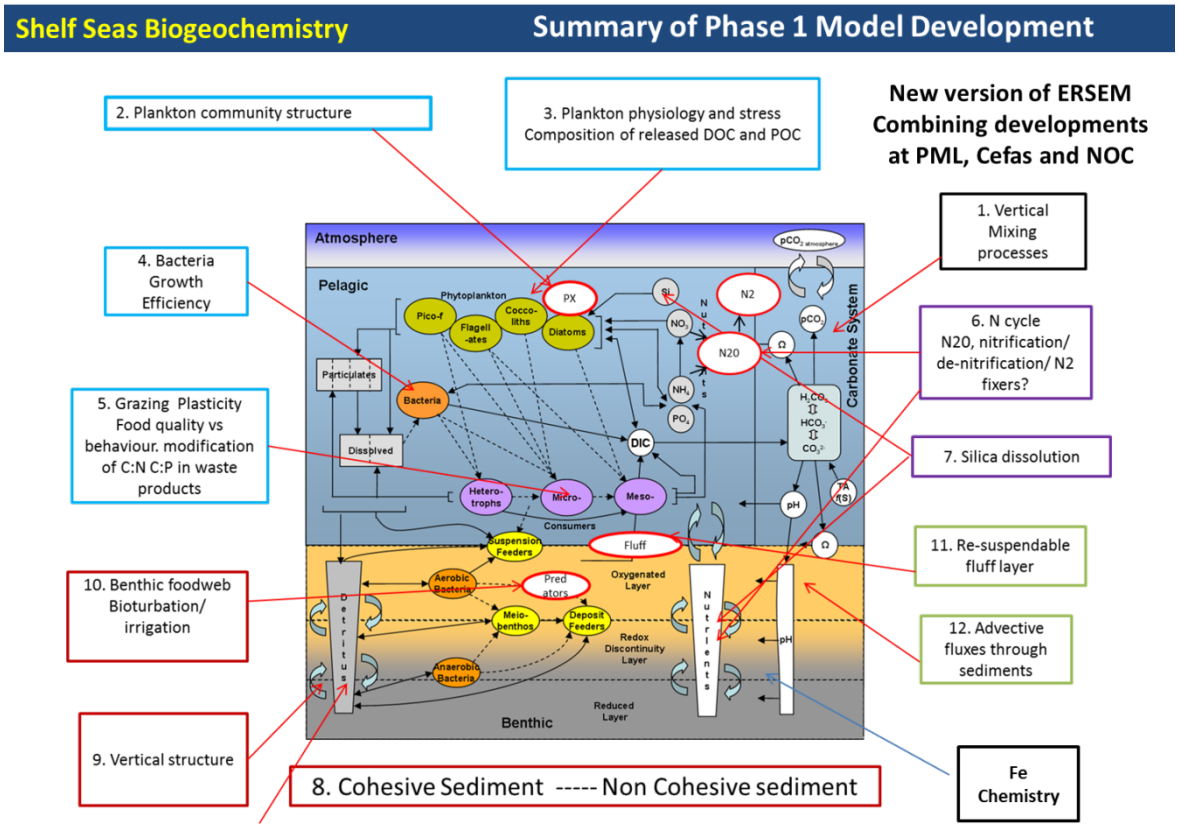

Figure 1. Proposed areas of process model development.

We will establish a new common model version for the European Regional Seas Ecosystem Model (ERSEM), drawing from the combined expertise of the partners. Exploiting, existing data, and new biogeochemical process understanding generated by the SSB program we will improve existing process models and develop new ones as appropriate, for both the physical and biological models. We will develop collaborations with the observational and experimentally focussed scientists working on the entire SSB programme in order to make best use of the available expertise. This will form the basis of the new community model system which will be supported and made freely available to the wider UK and international research communities, including SSB students. The resultant model will be used to make simulations of past present and potential future sates of the biogeochemistry of the UK shelf.

In summary, the project will provide new modelling tools which provide estimates of crucial information to help resolve key scientific questions as well as provide a better understanding of the functioning of the shelf seas as they respond to global change and direct anthropogenic pressures. The combination of predictive tools and new knowledge will underpin the development and implementation of marine policy and the implementation of marine forecast systems.