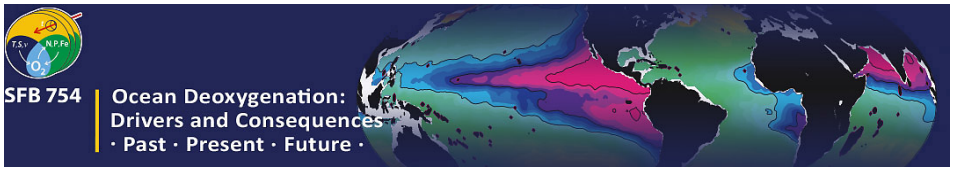

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Oxygen concentrations from water column to seabed – integrating observations and modelling to support assessments of status and predict change

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Shelf seas and their coastal areas are highly dynamic environments subject to many natural processes and anthropogenic pressures. They exhibit large spatial and seasonal gradients in pelagic and benthic oxygen concentrations both naturally with depth, temperature, hydrography, stratification and sediment type and in response to a range of pressures including anthropogenic nutrient inputs, trawling and climate change. Dissolved oxygen concentration is used as a measure of ecosystem health for formal eutrophication assessments under agreements and directives such as OSPAR, MSFD and WFD. It is also a fundamental control on other carbon and nutrient processes within the pelagic and benthic systems. Understanding the key processes controlling shelf sea oxygen concentrations is essential if we are to take appropriate management action and adapt to future changes.

In this contribution, we will present a synthesis of work carried out over the last two decades. The extent and magnitude of oxygen depletion in the water column in seasonally stratified UK shelf seas has been determined using high frequency in situ observations from moorings (surface and bottom) and gliders. These observations demonstrated that low values can occur, and are a normal feature of such shelf seas.

The penetration of oxygen into the seabed and its coupling to seasonal water column conditions is also spatially variable. Microelectrode insertion into sediment cores was used extensively in different parts of the UK shelf sea to record oxygen profiles in surficial sediments. The level to which free oxygen is present is driven primarily by sediment characteristics, such as particle size and organic matter content, their combined impact on permeability and hence pore-water exchange with the overlying water. In turn, it determines zonation and rates and pathways of redox sensitive elemental cycles and carbon mineralisation. While oxygenation of the seabed is not formally used as an indicator in assessments, it has high relevance for present and future seabed function.

Furthermore, ecosystem models which couple the water column and seabed components were used to predict horizontal and vertical oxygen distributions under various scenarios of present day and climate change conditions. In addition, recent oxygen mass-balance model developments have been made which provide robust estimates of net community production in shelf seas.

Challenges of representing oxygen distributions accurately throughout the water column and into the bed will be discussed in the context of spatial variability, seasonality, climate change and associated model process parameterisation and outputs.

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