



Spatial extent and historical context of North Sea oxygen depletion in August 2010

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Prompted by recent observations of seasonal low dissolved oxygen from two moorings in the central North Sea, a hydrographic survey in August 2010 mapped the spatial extent of summer oxygen depletion. In marine environments, the oxygen either diffuses from the atmosphere or is produced by photosynthesising organisms in the euphotic layer, and is then transported by currents to different regions or mixed to depths where it is utilised. Dissolved oxygen depletion arises in situations where the rate of oxygen supply is less than the rate of consumption for a significant period.

Typical near bed dissolved oxygen saturations in the stratified regions of the North Sea were 75-80% while the well-mixed regions of the southern North Sea reached 90%. Two regions of strong thermal stratification, the area between the Dooley and Central North Sea Currents and the area known as the Oyster Grounds, had oxygen saturations as low as 65% and 70% (200 and $180 \mu\text{mol dm}^{-3}$) respectively.

Low dissolved oxygen was apparent in regions characterised by low advection, high stratification, elevated organic matter production from the spring bloom and a deep chlorophyll maximum. The constant consumption of oxygen for the remineralisation of the matter exported below the thermocline exceeded the supply from horizontal advection or vertical diffusion.

Historical data over the last century from the International Council for the Exploration of the Sea (ICES) oceanographic database highlight an increase in seasonal oxygen depletion and a warming over the past 20 years. Regions showing sub-saturation oxygen concentrations were identified in the central and northern North Sea post-1990 where previously no depletion was identified. This correlated with an increased temperature signal but could not be entirely explained by the temperature-driven decrease in solubility. The 2010 survey is consistent with, and reinforces, the signal of recent depleted oxygen at key locations seen in the (albeit sparse) historical data.