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Using observations from gliders to understand oxygen dynamics in shelf seas

The decline in global ocean dissolved oxygen (DO) concentrations, particularly in shelf seas, has led to an immediate need to better understand the multitude of process that control the DO distribution. Recent model studies using regional-scale, coupled physical-ecosystem models estimate that large regions of the Northwest European Continental shelf seas (325,000 to 400,000 km2) have the potential to become deficient in DO during the latter stages of seasonal stratification. Here we use glider measurements of turbulence and DO to estimate vertical DO fluxes across the thermocline between the well oxygenated surface mixed layer (SML) and dark bottom mixed layer (BML) over 40 days during the spring bloom and summer stratified period in the central Celtic Sea. Rates of respiration in the BML and the diapycnal flux of DO across the thermocline were quantified. The change in oxygen over time and consideration of vertical flux allowed for the estimation of oxygen consumption in the BML, which agreed well with direct observations of respiration. The vertical DO flux was twice as high in summer relative to spring due to a strong vertical DO gradient. Enhanced mixing during the spring tide increased the vertical DO flux by 9-fold. Diapycnal mixing replenished up to 18% of the DO consumed in the BML during the stratified period, with a significant proportion of this being due to the spring tide. Without the diapycnal flux of DO, the BML DO would reach levels approaching ecological risk, this result has important consequences for marine ecosystem health in shelf seas since the observed ventilation mechanism of diapycnal mixing likely elevates oxygen levels relative to what would otherwise be considered. In order to correctly predict oxygen levels in shelf seas, the internal mixing needs to be quantified accurately.

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