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Seasonal net and gross biological oxygen production in a temperate shelf sea from oxygen-argon-ratio and oxygen triple isotopes.

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Temperate shelf seas are major carbon sink areas. Quantifying accurately primary production is therefore essential to understand the shelf sea carbon pump and its role in the uptake of anthropogenic CO_2 emissions.

Here we use high-resolution dissolved oxygen-to-argon (O_2/Ar) ratios and oxygen triple isotopes (^{16}O, ^{17}O and ^{18}O) to derive estimates of net and gross biological oxygen production in the Celtic Sea during the most productive seasons (spring, summer and autumn) in 2014-2015. O_2/Ar ratios were measured continuously using a shipboard membrane inlet mass spectrometer (MIMS). Additional discrete water samples obtained from CTD hydrocasts were used to measure O_2/Ar depth profiles and the $\delta(^{17}O)$ and $\delta(^{18}O)$ values of dissolved O_2.

Calculations of net ($N(O_2/Ar)$) and gross ($G(^{17}O)$) oxygen fluxes showed higher values during the spring bloom and lowest during the autumn bloom. Continuous $N(O_2/Ar)$ underway measurement was on average (58$\pm$38) mmol m^{-2} d^{-}1 and discrete $G(^{17}O)$ measurements was average (170$\pm$161) mmol m^{-2} d^{-1} during the spring bloom. Results from the summer cruise showed a peak in production just below the mixed layer. These peaks are not detectable by high coverage ocean colour satellite systems, typically used to calculate total annual production. Our results show primary production values at unprecedentedly high resolution in the shelf sea.