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Sustaining nutrient supply and carbon export in a seasonally-stratifying shelf sea through inconsistent production and remineralisation stoichiometry

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Continental shelf seas support 15-20% of global primary productivity despite covering only about 5% of the Earth's ocean surface area. As a result, they may have a significant role in oceanic uptake and storage of carbon dioxide (CO_2) from the atmosphere, through the 'continental shelf pump' mechanism. The northwest European continental shelf, in particular the Celtic Sea (50°N 8°W), was the target of extensive biogeochemical sampling from March 2014 to September 2015, as part of the UK Shelf Sea Biogeochemistry research programme (UK-SSB). Here, we use the UK-SSB carbonate chemistry and macronutrient measurements to investigate the biogeochemical seasonality in the temperate, seasonally-stratifying Celtic Sea. During the spring-summer, near-surface biological activity removed dissolved inorganic carbon and nutrients, some of which were then exported into the deeper layer. We calculated vertical inventories of these variables throughout 1.5 seasonal cycles and attempted to correct these for air-sea CO_2 exchange, advection and denitrification, thus isolating the combined effect of net community production and remineralisation on the inorganic macronutrient inventories, and revealing fluctuating deviations from Redfield stoichiometry. Here, we discuss the capacity of these stoichiometric inconsistencies to sustain the Celtic Sea nutrient supply, and thus examine whether an effective continental shelf pump for CO_2 could operate in this region.