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TITLE: Oceanic controls on the primary production of the northwest European continental shelf: model experiments under recent past conditions and a potential future scenario

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ABSTRACT:

Abstract. In this paper we clearly demonstrate that changes in oceanic nutrients are a first order factor in determining changes in the primary production of the northwest European continental shelf on time scales of 5?10 yr. We present a series of coupled hydrodynamic ecosystem modelling simulations, using the POLCOMS-ERSEM system. These are forced by both reanalysis data and a single example of a coupled ocean-atmosphere general circulation model (OA-GCM) representative of possible conditions in 2080?2100 under an SRES A1B emissions scenario, along with the corresponding present day control. The OA-GCM forced simulations show a substantial reduction in surface nutrients in the open-ocean regions of the model domain, comparing future and present day time-slices. This arises from a large increase in oceanic stratification. Tracer transport experiments identify a substantial fraction of on-shelf water originates from the open-ocean region to the south of the domain, where this increase is largest, and indeed the on-shelf nutrient and primary production are reduced as this water is transported on-shelf. This relationship is confirmed quantitatively by comparing changes in winter nitrate with total annual nitrate uptake. The reduction in primary production by the reduced nutrient transport is mitigated by on-shelf processes relating to temperature, stratification (length of growing season) and recycling. Regions less exposed to ocean-shelf exchange in this model (Celtic Sea, Irish Sea, English Channel, and Southern North Sea) show a modest increase in primary production (of 5?10%) compared with a decrease of 0?20% in the outer shelf, Central and Northern North Sea. These findings are backed up by a boundary condition perturbation experiment and a simple mixing model.

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