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NW European shelf productivity under climate warming: Implications for shelf carbon absorption

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Shelves have been estimated to account for more than one third of the global marine primary production. Enhanced biological productivity and carbon fixation on shelves is assumed by several authors to play a key role for both, the economic basis for industrial fishery and the oceanic absorption of atmospheric CO_2. In model climate projections we find that already a moderate warming of 1.7 to 2.0 K of the sea surface reduces biological production on the NW European shelf by $\sim$35%. This reduction is twice as strong as the reduction in the open ocean. Shelf productivity is thus much more vulnerable to climate warming than the open ocean productivity. The underlying mechanism is a spatially well confined stratification feedback along the continental shelf break which reduces the nutrient supply from the deep Atlantic by up to 50% with subsequent reductions in biological activity.
Carbon absorption on the NW European shelf decreases by 1/3 at the end of the 21^{st} century compared to the end of the 20^{th} century implying a strong weakening of shelf carbon pumping. Diagnostic tracer experiments indicate, however, that shelf sea pumping plays not an essential role in removing CO_2 from the atmosphere because most water exported to the open ocean remains within the mixed layer where it is still exposed to the atmosphere. For the North Sea we estimate that only $\sim$20% of the absorbed carbon has the potential for long term sequestration in the open ocean.