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Changes in water mass exchange between the NW shelf areas and the North Atlantic and their impact on nutrient/carbon cycling

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Despite their comparatively small extension on a global scale, shelf areas are of interest for several economic reasons and climatic processes related to nutrient cycling, sea food supply, and biological productivity. Moreover, they constitute an important interface for nutrients, pollutants and freshwater on their pathway from the continents to the open ocean.

This modelling study aims to investigate the spatial and temporal variability of water mass exchange between the North Atlantic and the NW European shelf and their impact on nutrient/carbon cycling and biological productivity. For this, a new modeling approach has been set up which bridges the gap between pure shelf models where water mass transports across the model domain too strongly depend on the formulation of open boundaries and global models suffering under their too coarse resolution in shelf regions. The new model consists of the global ocean and carbon cycle model MPIOM/HAMOCC with strongly increased resolution in the North Sea and the North Atlantic coupled to the regional atmosphere model REMO. The model takes the full luni-solar tides into account. It includes further a 12 layer sediment module with the relevant pore water chemistry.

The main focus lies on the governing mechanisms of water mass exchange across the shelf break and the imprint on shelf biogeochemistry. For this, artificial tracers with a prescribed decay rate have been implemented to distinguish waters arriving from polar and shelf regions and those that originate from the tropics. Experiments were carried out for the years 1948 – 2007. The relationship to larger scale circulation patterns like the position and variability of the subtropical and subpolar gyres is analyzed. The water mass exchange is analyzed with respect to the nutrient concentration and productivity on the European shelf areas.

The implementation of tides leads to an enhanced vertical mixing which causes lower sea surface temperatures compared to simulations without tidal forcing. The simulated tidal currents exceed velocities of 30cm per second in the near bottom layer which leads to a strong resuspension of sediment particles. These effects are most pronounced along narrow and shallow topographic structures like e.g. the English Channel. Experiments with artificial tracers show that the composition of water column changes along with the induced climate warming.