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Modelling the carbon budget of the northwest European continental shelf

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Phytoplankton growth in the nutrient-rich waters of the northwest European continental shelf takes up dissolved inorganic carbon and acts to drawdown CO_2 from the atmosphere. The deeper water becomes relatively rich in carbon through the sinking of detritus and through an excess of respiration over photosynthesis. Carbon-rich water below the summer thermocline is isolated from release to the atmosphere as long as the water column remains stratified. For the shelf region to be an effective sink of atmospheric CO_2, carbon must be transported from the shelf before the onset of autumn storms breaks down the stratification, mixing the water column from surface to bed. Here we construct a carbon budget for the northwest European continental shelf and investigate how carbon inputs from the atmosphere and land (through rivers) are transported from the European shelf to the open ocean. Both physical and biological processes are evaluated, including exchanges between the water column and the atmosphere and sea bed. We use a coupled 3D hydrodynamic-ecosystem model (POLCOMS-ERSEM) driven by realistic atmospheric data, ocean boundary conditions and freshwater inputs for 1989 to 2004. Dominant features of the large scale circulation of the region include a northwards-flowing slope current along the edge of the continental shelf and a generally cyclonic circulation in the North Sea. The Norwegian Coastal Current is the main pathway for water leaving the North Sea while an Ekman drain below the slope current transports water off shelf in a thin layer near the bed. We explore the depth-resolved carbon transport between the shelf and the open ocean, integrating the large scale circulation with the seasonal carbon cycle, and investigate its inter-annual variability.