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Carbon exchange between the northwest European continental shelf and the North Atlantic Ocean

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Phytoplankton growth in the nutrient-rich waters of the northwest European continental shelf takes up dissolved inorganic carbon (DIC) and acts to drawdown CO_2 from the atmosphere. Deeper water becomes relatively rich in carbon through the sinking of detritus and because, as light levels fall, respiration exceeds photosynthesis, leading to the release of DIC. 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. A 16-year simulation of the Proudman Oceanographic Laboratory Coastal Ocean Modelling System (POLCOMS) coupled to the European Regional Seas Ecosystem Model (ERSEM) is used to investigate how carbon inputs from the atmosphere and land (from rivers) are transported from the European shelf to the open ocean. Dominant features of the large scale circulation of the region include generally cyclonic circulation in the North Sea and a northwards-flowing slope current along the edge of the continental shelf. 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.