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Developing understanding of the shelf seas and their role in the global ocean

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The shelf seas have an importance which is disproportionate to the relatively small fraction ($\sim$8%) of the total ocean area which they occupy. They are responsible for a large percentage of the carbon fixation which occurs in the ocean and, in consequence, are postulated to contribute substantially to the ocean's capacity to take up CO_2 . The shelf seas are also of substantial practical importance to humanity as major sources of fish, hydrocarbons and aggregates. In addition, they have been much used as a low-cost sinks for domestic and industrial wastes. In order to manage the shelf seas effectively with predictive models and determine their role in, and response to, climate change, we need first to understand the physical processes operating in the shelf sea regime which differs radically from that of the deep ocean. In this lecture, I will consider the major processes operating in different characteristic regions of the shelf seas and show how they interact to determine the structure and circulation. In areas where surface heat flux dominates the buoyancy input, competition with stirring controls the vertical structure and results in horizontal gradients that make a major contribution to the baroclinic circulation. Where freshwater input from rivers is an important buoyancy source, lateral gradients drive an estuarine circulation which again competes with stirring by tide and wind but in this case there is the added complication of tidal straining which acts to produce periodic stratification and to enhance estuarine circulation. These processes will be discussed in the light of recent direct measurements of turbulence which have revealed deficiencies in the boundary mixing paradigm and point to the need for an additional energy source to drive the internal mixing which is needed to sustain primary production in stratified areas.