AOGS 2005

Nitrogen and Carbon cycling in the Middle Atlantic Bight: Results from a three-dimensional nested model

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Biogeochemical processes in continental shelf systems play a quantitatively important role in the global elemental cycles of nitrogen and carbon, but remain poorly quantified. We are developing high-resolution physical-biological models for the U.S. east coast continental shelf and adjacent deep ocean in order to hindcast these fluxes in the shelf area of the Middle Atlantic Bight. Our regional models are nested within a basin-wide North Atlantic model to simulate the influence of circulation processes outside of the regional domains, such as the subtropical gyre circulation, Gulf Stream mesoscale variability, and inflows from the Gulf of Mexico and the Labrador Sea. Our biological model is a relatively simple representation of nitrogen cycling processes in the water column and organic matter remineralization at the water-sediment interface that explicitly accounts for sediment denitrification. Model/data comparisons of climatological and regionally integrated means of surface chlorophyll, primary production and denitrification, and statistical measures of pattern variability show good overall agreement, although certain features, for example the high productivity on Georges Bank, are not currently resolved in the model. Model scenarios where river inputs of nitrogen and sediment denitrification fluxes are removed, and a nitrogen budget for the Middle Atlantic Bight both show that the denitrification flux is quantitatively important in determining the shelf primary production and the availability of fixed nitrogen. Extrapolation of nitrogen fluxes estimated for the Middle Atlantic Bight to the North Atlantic basin suggests that shelf denitrification is an important nitrogen sink that exceeds recent estimates of N_2 fixation by an order of magnitude. Our results emphasize the importance of representing shelf processes in biogeochemical models and demonstrate that the spatial nesting of a regional shelf model with a basin-wide domain is a feasible approach to accomplish this.