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Interannual Variability of Primary Production and Carbon Fluxes on Northeast North American Shelf: Sensitivity to Climate Change?

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The role of continental shelf systems as a sink or source of atmospheric CO2 in global carbon budgets is an open question. Current thinking suggests that some of the factors influencing shelf ecosystem production include variability in atmospheric forcing. We investigate the impact of interannual variability in atmospheric forcing on shelf production and the capacity of different shelf regions to act as a sink or source of atmospheric CO2. We present results from a biogeochemical model experiment along the US East Coast Continental Shelf (USECoS) and compare the response of three distinct regions (Gulf of Maine, Mid-Atlantic Bight and South Atlantic Bight) using two model scenarios. The first scenario, referred to as "present day" represents contemporary mesoscale variability in forcing as captured by NARR-NCEP 3-hourly fields from 2004 to 2007. The second scenario, referred to as "climate", adjusts the present day forcing to account for atmospheric anomalies derived from modern and future simulations of a regional climate model, RegCM3 forced by the NCAR Climate System Model for the beginning and end of the 21st century, indicative of a doubling of atmospheric CO2. Our present day interannual estimates of primary production agree well with satellite estimates. A clear along shelf gradient (south to north) in CO2 flux is present. The South Atlantic Bight acts as a small source of CO2 to the atmosphere, and to a lesser extent some coastal areas of the Mid-Atlantic Bight, while the Mid-Atlantic Bight Shelf and Slope waters and the Gulf of Maine act as stronger sinks of atmospheric CO2. The response of these regions to the adjusted climate scenario shows interesting changes in production estimates. Annual production decreases in the South and Mid Atlantic Bights, while it increases in the Gulf of Maine. We apply a 2nd order Taylor series decomposition analysis method to identify the important processes responsible for these climate-related variations in shelf production.