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Physical controls on biogeochemical dynamics along the land-ocean continuum: implications for coastal ocean modeling

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A two-dimensional, nested-grid hydrodynamic and reactive-transport model of the macrotidal Scheldt estuary, its tributaries and the adjacent coastal zone has been developed to identify the driving forces controlling the spatio-temporal carbon and macronutrient (N, Si) dynamics along a land-ocean continuum. In winter and early spring, the temporally-resolved fluxes within the estuary are primarily controlled by the river discharge and the large in-situ retention of nutrients. In late spring and summer, primary production and coupled ammonification/ nitrification/ denitrification in the upper estuary become increasingly more important for the dynamics of Si and N, respectively. Results reveal that the estuarine biogeochemical processes respond rapidly to changes in the physical environment, especially those due to daily variation in river discharge which continuously modify the suspended particulate matter concentrations, residence times and nutrient deliveries. At the estuarine mouth, the nutrient fluxes are driven by the complex interplay between the residual circulation and the transport of scalar concentration fields which respond differently to changes in hydrodynamic conditions resulting in important time lags. The phytoplankton succession and primary production in the coastal zone are mainly controlled by the Lagrangian residual circulation and the nutrient influx from the estuary. The spreading of the nutrient-rich estuarine plume determines the distribution of the production-recycling loop, with high production rates close to the estuarine mouth and enhanced recycling further offshore. Simulation results indicate the dominant influence of physical forcing on the

biogeochemical dynamics along the morphologically complex land-ocean continuum.