Geophysical Research Abstracts,
Vol. 10, EGU2008-A-06677, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-06677
EGU General Assembly 2008
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Estuarine controls on the coastal ocean sink of CO_2: a reactive-transport modelling study

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Coastal areas receiving carbon and nutrient inputs from land play a significant role in the global carbon cycle. Previous budget calculations show that both the magnitude and the direction of the air-water CO_2 fluxes in these areas are largely controlled by riverine nutrient and carbon loads. Before reaching the coastal sea, terrestrial nutrients and carbon (in organic and inorganic forms) are profoundly modified in the estuary changing the amount and form of carbon and nutrient delivered to the adjacent coastal zone. These transformation processes rely on the physical characteristics of the estuary and the anthropogenic loads. In order to investigate the effect of the estuarine biogeochemical filter, a two-dimensional, nested-grid hydrodynamic and reactive-transport model was developed to determine the quantitative significance of the Scheldt estuary on the fluxes of carbon to Belgian coastal waters. Seasonal evolution of the main biogeochemical components of the ecosystem was described by coupling the MIRO model and a description of the carbonate system within this reactive-transport model. Model simulations were carried out along the continuum of the Scheldt river, estuary and the Belgian coastal zone and validated with pCO_2 data at different stations along the river- coastal continuum. Sensitivity tests are then used to investigate how inner estuarine processes and resulting fluxes to the sea may alter the trapping efficiency of CO_2 in the Belgian coastal zone.