Carbon Dynamics in Northern Marginal Seas

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Abstract

The marginal seas have, despite their relatively small area, an important role in the global carbon cycle. They are largely influenced by carbon and nutrient fluxes from land and a large part of the biological production occurs in the marginal seas.
The carbon dynamic in two shelf areas – The Baltic Sea System (the Baltic Sea, the Kattegat and the Skagerrak) and the Siberian Shelf Seas (the Laptev Sea, the East Siberian Sea and the Chukchi Sea) has been studied in this thesis.
Results from a study using historical data on Total Alkalinity (TA) from the Baltic Sea shows that there has been a change in the riverine TA concentrations. TA has increased in rivers draining areas where limestone dominates the bedrock while there has been a decrease in TA concentrations in granite dominated areas. We give two explanations to this change; acid precipitation and increased concentrations of CO_2 from decay of organic matter.
The Baltic Sea has high DIC concentration relative to its salinity (also due to river input) and as the surface water leaves the Baltic Sea also the DIC is exported and will in the end add to the North Sea carbon budget. We estimated the net carbon export from the Baltic Sea to 5.5 ± 0.3 Tg C $year^{-1}$.
Furthermore, the carbon dynamics in the Skagerrak during 2006 has been studied and we found it to be a sink of carbon with a sea-air flux of $1.3 \cdot 10^{12}$ mol m^{-2} $year^{-1}$. We also found Skagerrak to be a reasonable source of carbon to the North Sea by a continental shelf pump.
In the Arctic and especially in the Laptev Sea, the large amounts of organic carbon transported by the major Russian rivers as well as from coastal erosion will decay in the shelf seas. This will result in a net efflux of CO_2 to the atmosphere. However, in the eastern part of the East Siberian Sea and in the Chukchi Sea, the river discharge is much less and the biological activity is high. This will instead cause under-saturated surface waters in respect to CO_2. The particulate organic carbon produced in the surface will sediment and starts to decay in the bottom water. As the water flows off the shelf and in to the Arctic Ocean this will result in surface waters under-saturated in pCO_2 and subsurface waters over-saturated in pCO_2.
The marginal seas investigated in the thesis are located in the northern hemisphere and there are fundamental differences in temperature and population density along the coasts. Nevertheless, both areas are influenced by the properties and the carbon content in the entering river water and both areas appear to export carbon to the open ocean trough a continental shelf pump.

KEYWORDS: dissolved inorganic carbon, total alkalinity, continental shelf pump, marginal seas, Baltic Sea, Skagerrak, Laptev Sea, East Siberian Sea, Chukchi Sea

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