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Controls on the CO2 system by benthic-pelagic coupling in the southern North Sea

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The shallowness of coastal seas permits close interaction between the sediments, the water column and the atmosphere. Furthermore, shallow coastal seas are regions of high primary production which leads to high fluxes of organic matter to the sediment. In the context of coastal oceans acting as a continental shelf pump, that is transferring CO2 from coastal seas into the open ocean, the role of benthic processes are only partly understood.

Recent studies from the East China Sea and the North Sea show that sediments could play a more important role than previously anticipated. This so-called “benthic-pelagic alkalinity connection” states that anaerobic mineralization of organic matter in sediments are an important alkalinity source for coastal seas like the North Sea.

During a basin wide North Sea cruise in September 2011, we measured rates of sedimentary alkalinity (TA) generation within permeable and muddy sediments of the North Sea at 19 stations. Using closed sediment incubations, benthic fluxes of alkalinity, dissolved inorganic carbon, nutrients and oxygen were determined. In May 2012 we sampled an additional 7 stations in the Dutch coastal zone for the same parameters.

Here we present preliminary results from both cruises. In the northern North Sea benthic TA fluxes were zero. For the southern North Sea TA fluxes varied between 0 and 21 mmol m-2 d-1 (September 2011) and 3-19 mmol m-2 d-1 (May 2012). Fluxes for dissolved inorganic carbon (DIC) were generally higher than TA fluxes with a maximum of 29 mmol m-2 d-1 (September 2011). Furthermore, positive correlations between oxygen consumption rates and TA/DIC fluxes are showing significant higher TA and DIC fluxes in sediments with high oxygen consumption rates compared to sediments with lower oxygen consumption rates.

Our results show that benthic fluxes are an important source for the TA and DIC budgets in the southern North Sea. Benthic alkalinity fluxes can potentially alter the pCO2 of the seawater and thus influence the CO2 uptake from the atmosphere. Alkalinity generation in sediments can therefore play an important role in the pH dynamics and therefore acidification in coastal systems.