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Identifying the responses of the carbonate system and its governing processes in three high latitude shelf seas: Barents Sea, North Sea and Baltic Sea.

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The increasing concentration of atmospheric CO_2 is the main driver for the long-term trends in the ocean carbon chemistry on a global scale. However, this signal is modulated at regional scales by the physical and ecological dynamics of the area. Circulation, temperature and primary production modify pCO_2 in the water either directly or indirectly via alkalinity or DIC. The contribution of the individual processes to the overall changes varies in different regional settings. The aim of this work is to identify and describe the specific regional responses of the carbonate system to several forcings in three distinct ecosystems in the North Atlantic (the North Sea, the Baltic Sea and the Barents Sea) and on inter-annual to multi-decadal time scales.

Despite their relative geographical proximity, these shelf systems exhibit very different dynamics. The North and Barents Seas receive important inflows of Atlantic waters, while the Baltic Sea is an almost enclosed system, with very little inflow from the North Sea. Wind, tides, freshwater supply and ice cover act very differently in the three systems, but dominantly structure the ecosystem dynamics on spatial and temporal scales. These particular features have a strong impact in the biogeochemical cycles and ultimately shape the variations in the carbonate chemistry.

Here the ECOSMO model was employed for a 60-year period (1947-2007). ECOSMO is a 3-D coupled physical-biogeochemical model including a carbon chemistry module. The biogeochemical model resolves the cycles of nitrogen, phosphorus and silicate, includes 3 functional groups of phytoplankton and 2 groups of zooplankton. pH and pCO_2 are calculated from alkalinity and DIC, which are prognostic variables in the model.

The model output for alkalinity, DIC, pH and pCO_2 is compared and validated with observations available in several databases. Additionally, the model sensitivity is tested with respect to the boundary conditions of alkalinity and DIC.