Structure and functioning of the acid-base system in the Baltic Sea

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The Baltic Sea is one of the largest brackish ecosystems in the world. In parallel to low salinity, the buffer capacity of the Baltic Sea water is also low. This causes the seawater acidification due to increasing atmospheric CO_2 levels is a serious threat for the Baltic Sea ecosystem. However, current approach ignores the complexity of the acid-base system of the Baltic Sea and the fact that it may undergo further modifications due to climate change and anthropogenic activities. Furthermore, models of the Baltic Sea biogeochemistry are based, to a large degree, on the approaches developed for the open ocean. However, processes such as eutrophication, significant input of organic substances from land, variations in total alkalinity, a pronounced seasonality and steep spatial gradients of seawater properties make the structure of the Baltic Sea acid-base system unique and highly variable in space and time. These considerations are likely to be of importance also for other coastal and land-locked seas.

The major goal of this study was to characterize the structure and functioning of the acid-base system of the Baltic Sea. The processes and interactions which were insufficiently characterized or were entirely missing in the description of the Baltic Sea acid-base system have been identified and eperimentally parameterized. These include e.g.: quantification of the dissolved organic matter influence on the pH and total alkalinity, identification of spatial distribution of borate alkalinity, quantification the contribution of suspended carbonates as a carrier of total alkalinity. The obtained results showed that ignoring the local pecularities of the acid-base system structure causes significant uncertainty in the modelling of the pH and pCO_2 in the Baltic Sea. Large differences were found between the measured and calculated pCO_2 and pH. The calculated pCO_2 was 27–56% lower than the measured values whereas the calculated pH was overestimated by as much as 0.4 pH units.