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Interactions between variations in the depth of the oxycline and carbonate chemistry in the Black Sea

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Current climate scenarios predict warming of the oceans, decreasing pH and loss of dissolved oxygen for the next century. The Black Sea is a strongly stratified basin; 90 % of its water body are anoxic. Observations and model studies have evidenced a shallowing of the oxycline over the past 40 years. The presence of oxygen is crucial for most marine organisms and therefore directly influences respiration rates and pelagic CO_2 production. Also under anaerobic conditions, microorganisms use other electron acceptors (nitrate, manganese, sulfate etc.) to mineralize organic matter. These various anoxic reactions and potential aerobic/anaerobic couplings in case of reoxidation of reduced species (oxygen demand units (ODU) = NH_4^+, Mn^{2+}, Fe^{2+} HS^- etc.) impact the carbonate system by increasing or decreasing the pH. In turn, changes in pH affect the speciation of dissolved inorganic carbon and finally air-sea CO_2 fluxes. To understand how the predicted changes will affect the CO_2 uptake potential of the Black Sea, a model study has been conducted using the Biogeochemical Model for Hypoxic and Benthic Influenced Areas (BAMHBI). This model uses 28 state variables and 256 parameters to represents the pelagic food webs and biogeochemical processes including an explicit representation of the anaerobic degradation of organic matter and of the carbonate system. BAMHBI is used in the frame of the Copernicus Marine Environment and Monitoring Service (CMEMS) for forecasting the Black Sea's biogeochemistry as done by the Black Sea Marine Forecasting Center (BS-MFC). Model predictions are validated with observations from BGC Argo floats (e.g. Chlorophyll, light, oxygen particles) and errors skills are estimated. In a first step, the impact of the ascent of the oxycline and warming on the carbonate system and associated air-sea CO_2 exchanges were analyzed under a 1D configuration. The aim of this study is to expand from this analysis of past changes towards the changes predicted by current climate change scenarios. The results will help to improve our current understanding of the feedbacks between deoxygenation and carbonate dynamics and refine the predicted changes in the carbon budget of the Black Sea and potentially in other areas experiencing oxygen loss.