Impacts of Artificial Limestone Weathering on Carbonate Chemistry of the North Sea – A Model Study

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Artificial limestone weathering (ALW) is a procedure that imitates naturally occurring carbonate rock weathering and reduces CO_2-emissions to the atmosphere. In a reaction vessel, CO_2 of an effluent gas stream, H_2O and $CaCO_3$ react to $2HCO_3^-$ and Ca^{2+}. The resulting solution can be released into marine or limnic systems. In comparison to classical carbon capture and storage (CCS) methods ALW is cheaper and does not involve using toxic chemical compounds. Additionally, storage concepts for the retained CO_2 are not required. Besides reducing CO_2-emissions, the effluent water is characterized by enhanced alkalinity and contributes to the aquatic buffering capacity.

The unstructured-grid finite-volume community ocean model (FVCOM) was combined with a chemical submodul (mocsy) to model the carbonate chemistry, its hydrodynamic circulation and mixing after release of AWL-derived waters into natural systems. Our study area is the North Sea with focus on the German Bight. Around the North Sea multiple coal-fired power plants are located. These plants are preferred candidates for AWL-treatment as they emit high amounts of CO_2, use sea water for cooling purposes and feature an appropriate infrastructure for the delivery of limestone.

Here, we present results of two different scenarios: The release of effluent water originating from a demonstration plant (for small to medium-sized gas streams) or a full power plant. Local and regional impacts on the carbonate chemistry are evaluated on time scales of up to one year. Special interest lies in pH development and changes in calcite and aragonite saturation index, respectively. Potential outgassing of (captured) CO_2 is surveyed via calculation of air-sea fluxes.