Application of a generic estuarine model to coastal waters: a mechanistic understanding of pH and the carbonate system

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Located at the transition between rivers and the coastal ocean, estuaries are characterized by the mixing of waters with different properties resulting in complex biogeochemincal gradients including nutrients, Dissolved Inorganic Carbon (DIC), Alkalinity and pH. Estuaries are particularly affected by anthropogenic pressures and the perturbation of the carbonate cycle potentially resulting in water acidification. This contribution presents the application of a novel modeling tool to investigate and better understand the carbonate cycle in estuarine environments. The generic estuarine model C-GEM (for Carbon–Generic Estuary Model) allows the simulation of hydrodynamics, transport, and biogeochemistry for a wide range of estuarine systems using readily available geometric parameters and global databases of seasonal climatic, hydraulic, and riverine biogeochemical processes (e.g. net heterotrophy, nitrification, …).

C-GEM was used to perform the first regional-scale assessment of the estuarine carbon budget and CO_2 evasion along the US East Coast (25–45° N). This study included a validation of the model against measured pH profies along the Delaware Bay estuary and the Althamaha river. C-GEM is also applied to estuaries located in Western Europe with fully transient simulations over periods of time ranging from one year to decades. These simulations allow identifying the processes controlling the present day dynamics of the carbonate system and evaluating the potential response of estuaries to climate change through the 21st century.