Modelling Estuarine Biogeochemical and pH Dynamics: From the Local to the Global Scale

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Reactive transport models (RTMs) are powerful tools for disentangling the complex process interplay that drives estuarine biogeochemical dynamics, for assessing the quantitative role of estuaries in global biogeochemical cycles and for predicting their response to anthropogenic disturbances (land-use change, climate change and water management). Nevertheless, the application of RTMs for a regional or global estimation of estuarine biogeochemical transformations and fluxes is generally compromised by their high computational and data demands. Here, we describe C-GEM (Carbon-Generic Estuary Model), a new one-dimensional, computationally efficient RTM that reduces data requirements by using a generic, theoretical framework based on the direct relationship between estuarine geometry and hydrodynamics. Despite its low data demand, it is able to provide accurate descriptions of estuarine hydrodynamics, salt and sediment transport as well as biogeochemistry on the appropriate spatio–temporal scales, from catchment to the globe. In particular, C-GEM has been designed to simulate the estuarine pH dynamics resulting from the complex interplay between physical transport processes, organic and inorganic (DIC, Alkalinity) carbon cycling, as well as temperature and ionic strength effects on the dissociation constants of carbonate ions.