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Quantification of the seasonal dynamics of the estuarine CO_2 exchange at the air-water interface using a transient reactive transport model.

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Globally, estuaries emit between 0.1 and 0.2 Pg C every year to the atmosphere under the form of CO_2. However, large uncertainties remain associated to these fluxes, partly because of the scarcity of data available to constrain such global budget but also because of the difficulty to derive reliable annual estimates of the CO_2 exchange with the atmosphere at the system scale. In temperate regions, estuaries are generally characterized by strong biogeochemical gradients and often behave as CO_2 sinks at their marine boundary and strong CO_2 sources upstream. Moreover the intensity of these fluxes is also affected by large seasonal variations. Thus, numerical models able to resolve the CO_2 dynamics at the air-water interface, both in time and space are invaluable tools to better constrain the carbon exchange between estuaries and the atmosphere.
Here, as a first step, the application of the generic transport reactive model C-GEM (for Carbon Generic Estuarine Model) to the Seine estuary allows evaluating its performances in a well monitored and intensively studied system. Fully transient simulations over the entire year are performed to quantify the annually integrated CO_2 exchange at the air-water interface and better understand the evolution over the year and along the estuarine gradient of the CO_2 exchange with the atmosphere. These mechanistic simulations also provide insight on the processes controlling the estuarine inorganic carbon dynamics. Further application of C-GEM at the regional scale to the entire North East Atlantic coast and will provide an unprecedented insight regarding the seasonal dynamics of the CO_2 exchange.