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The spatiotemporal dynamics of the sources and sinks of CO2 in the global coastal ocean

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The spatio-temporal variability and the underlying drivers of the carbon dioxide (CO_2) exchange at the air-water interface (FCO_2) of the global coastal ocean are still poorly understood and their quantification remains highly uncertain. Here, we present an analysis of the spatial and seasonal variability of FCO_2 using a high-resolution (0.25 degree) monthly climatology (1998-2015 period) for coastal sea surface partial pressure in CO_2 (pCO_2), globally.

Overall, a clear latitudinal pattern emerges from our analysis regarding sources/sinks distribution of atmospheric CO_2 and we find that in most regions, annual mean CO_2 flux densities are comparable in sign and magnitude to those of the adjacent open ocean except for river dominated systems. Globally, coastal regions act as a CO_2 sink with a more intense uptake occurring in summer because of the disproportionate influence of high latitude coastal seas in the Northern Hemisphere. The majority of the coastal seasonal FCO_2 variations stems from the air-sea pCO_2 gradient, although changes in wind speed and sea-ice cover can also be significant regionally. To investigate further the drivers of the spatio-seasonal variability, our observation-based pCO_2 climatology is used in conjunction with global ocean biogeochemistry model MOM6-COBALT. The model outputs allow us to quantify the respective contributions of thermal effects, biology, and non-thermal physical processes (circulation and freshwater inputs) to seasonal variations in coastal pCO_2. Generally, biological activity is the dominant driver of the pCO_2 seasonal variability in temperate and high latitudes while thermal and non-thermal physical processes dominate in low latitudes.