Carbon dioxide in European coastal waters

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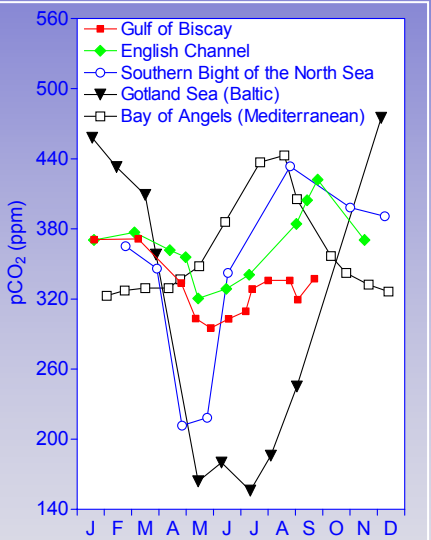
1 - Data

Data in 19 coastal environments were gathered from literature. Inner estuaries act as sources of CO_2 to the atmosphere. Upwelling and non-upwelling continental shelves act as moderate to strong sinks of atmospheric CO_2.

2 - CO_2 drivers over shelves

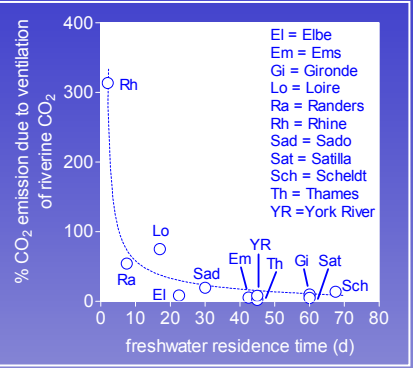
Full annual cycles of pCO_2 are available over 5 continental shelves. All the sites show a springtime decrease of pCO_2 except the oligotrophic Bay of Angels in the Mediterranean Sea, where the distinct increase of pCO_2 from early April to mid-August follows solely the one of temperature. The Gulf of Biscay and the Channel are characterized by a springtime decrease of pCO_2 similar in timing and amplitude. During summer, regenerated primary production maintains the low values attained during the spring bloom. An early fall phytoplankton bloom occurs in the Gulf of Biscay related to the input of nutrients owing to water column de-stratification.



In the English Channel, the increase of pCO_2 during fall probably results from heterotrophic processes related to the degradation of the organic matter accumulated during the earlier part of the seasonal cycle. The seasonal amplitude and in particular the spring decrease of pCO_2 in the Southern Bight of the North Sea is much larger than in the English Channel and the Gulf of Biscay. This is related to higher nutrient availability due to river inputs. In the Gotland Sea, characterized by nutrients levels equivalent to those in the Gulf of Biscay, the much higher seasonal amplitude of pCO_2 is related to the higher Revelle factor due to lower salinity and total alkalinity.

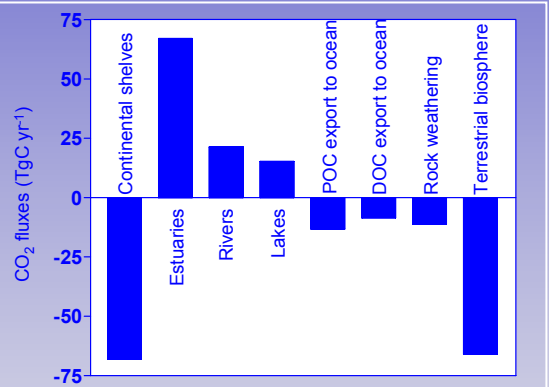
3 - CO_2 drivers in estuaries

In estuaries with a long freshwater residence time, the riverine CO_2 will be fully ventilated to the atmosphere within the estuary and the overall CO_2 emission from the estuary will be mostly related to heterotrophy. In estuaries with a very short freshwater residence time, the enrichment of DIC from heterotrophy will be less pronounced.



4 - EU comparison

The sink of atmospheric CO_2 over the EU continental shelf of about -68 TgC yr^{-1} is highly significant and comparable to the sink associated to the terrestrial vegetation of -66 TgC yr^{-1} (sum of grasslands, croplands, peatlands and forests).



However, the sink of CO_2 over continental shelves might be almost fully balanced by the emission of CO_2 from inner estuaries of about 67 TgC yr^{-1}. However, this value should be considered with caution and most probably corresponds to an over-estimate, due to poor estimate of the surface area covered by estuaries.

The emission of CO_2 to the atmosphere from continental aquatic compartments (streams, rivers and lakes) is highly significant when compared to the absorption of CO_2 from the atmosphere due to carbonate and silicate rock weathering, and to the export of organic carbon from rivers to the coastal ocean.

The CO_2 fluxes from continental aquatic compartments are not accounted for in atmospheric CO_2 inversion models and will increase the gap with estimates of the terrestrial carbon sink based on carbon-stock change models. On the other hand, the export of organic matter from rivers to the coastal ocean, and the CO_2 absorption from rock weathering are typically not accounted for in carbon-stock change models.

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